Assessing Risk to the Essential Fish Habitat of West Coast Groundfish

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Abstract

Assessment of essential fish habitat for groundfishes off the U.S. west coast has required a unique collaboration of experts from a variety of disciplines and presents an useful case study for migrating to an ecosystem-based approach. The assessment follows a decision-making framework that integrates detailed information on geologic and biologic substratum types, bathymetry, latitude, data quality, fish ecology, and anthropogenic risk factors together in an interpretive bayesian network model with GIS outputs. The assessment is designed to identify and profile the distribution and relative health of essential fish habitat and its associated risks from anthropogenic impacts to determine if policy intervention is desirable. While the scope of the assessment is limited to groundfish habitat and associated impacts, the decisionmaking framework lends itself to expansion for consideration of other ecosystem components. Due in large part to the scale of the study (the U.S. Exclusive Economic Zone from Canada to Mexico) and the broad range of relevant information, important challenges have arisen in stitching together and interpreting datasets of varying quality, content, and volume. The study has been guided by the Pacific Fishery Management Council (Council) under the mandate of the Magnuson-Stevens Fishery Conservation Act. This presentation will focus on the challenges of large-scale assessment and provide a brief overview of how the Council has applied the information in a policy setting.

Risk Assessment and Policy Development for Pacific Coast Groundfish EFH

September, 2004

Steve Copps (NMFS), Waldo Wakefield (NMFS), Mary Yoklavich (NMFS), Graeme Parkes (MRAG), Allison Bailey (Terralogic GIS)

Mandate(s)

Magnuson-Stevens

- describe and identify EFH; minimize to the extent practicable adverse effects of fishing; identify other actions to encourage conservation and enhancement

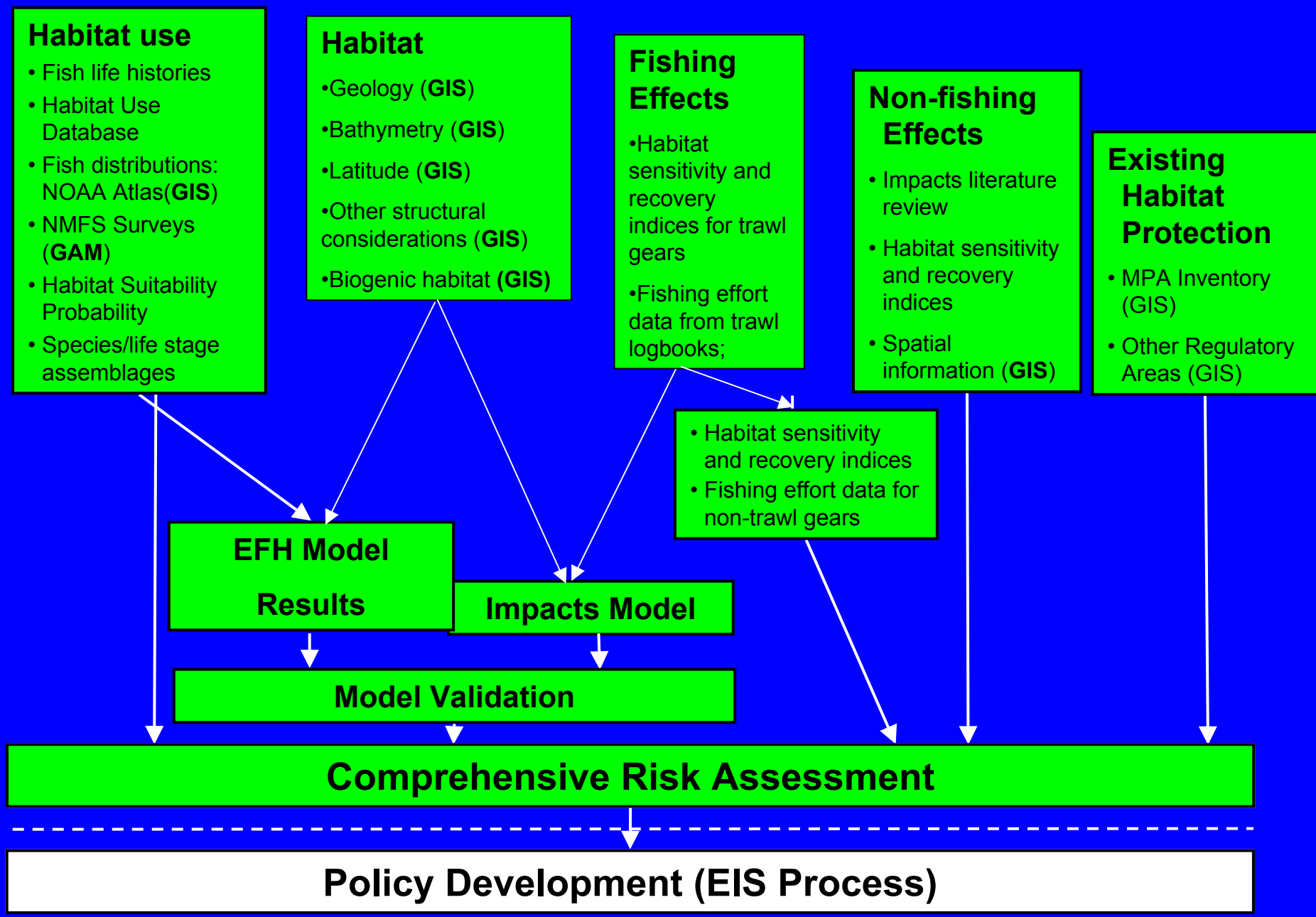
AOC v. Daley

- NEPA analysis, schedule, etc.

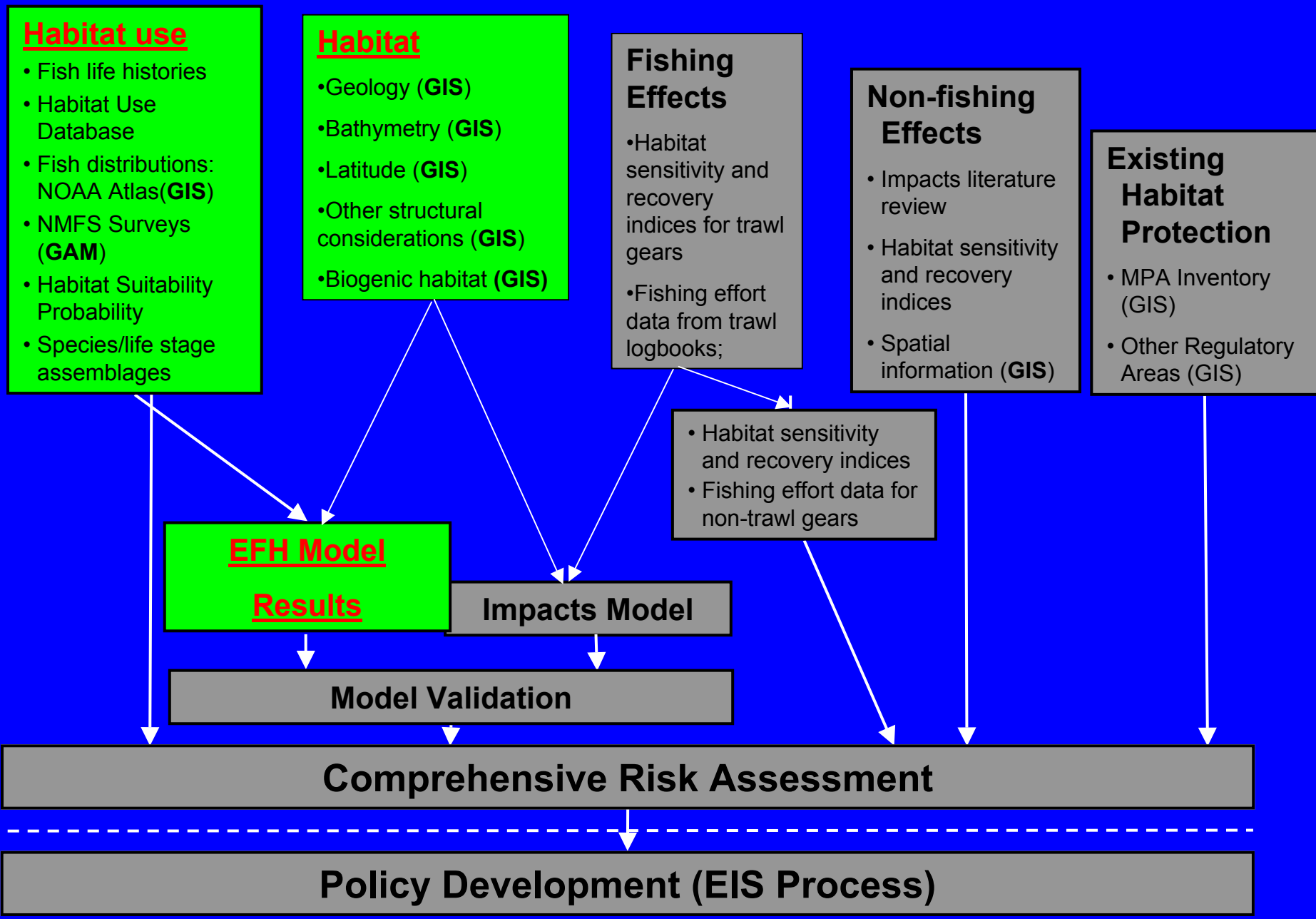
Agency Guidance

- Analytical requirements and guidance for EIS

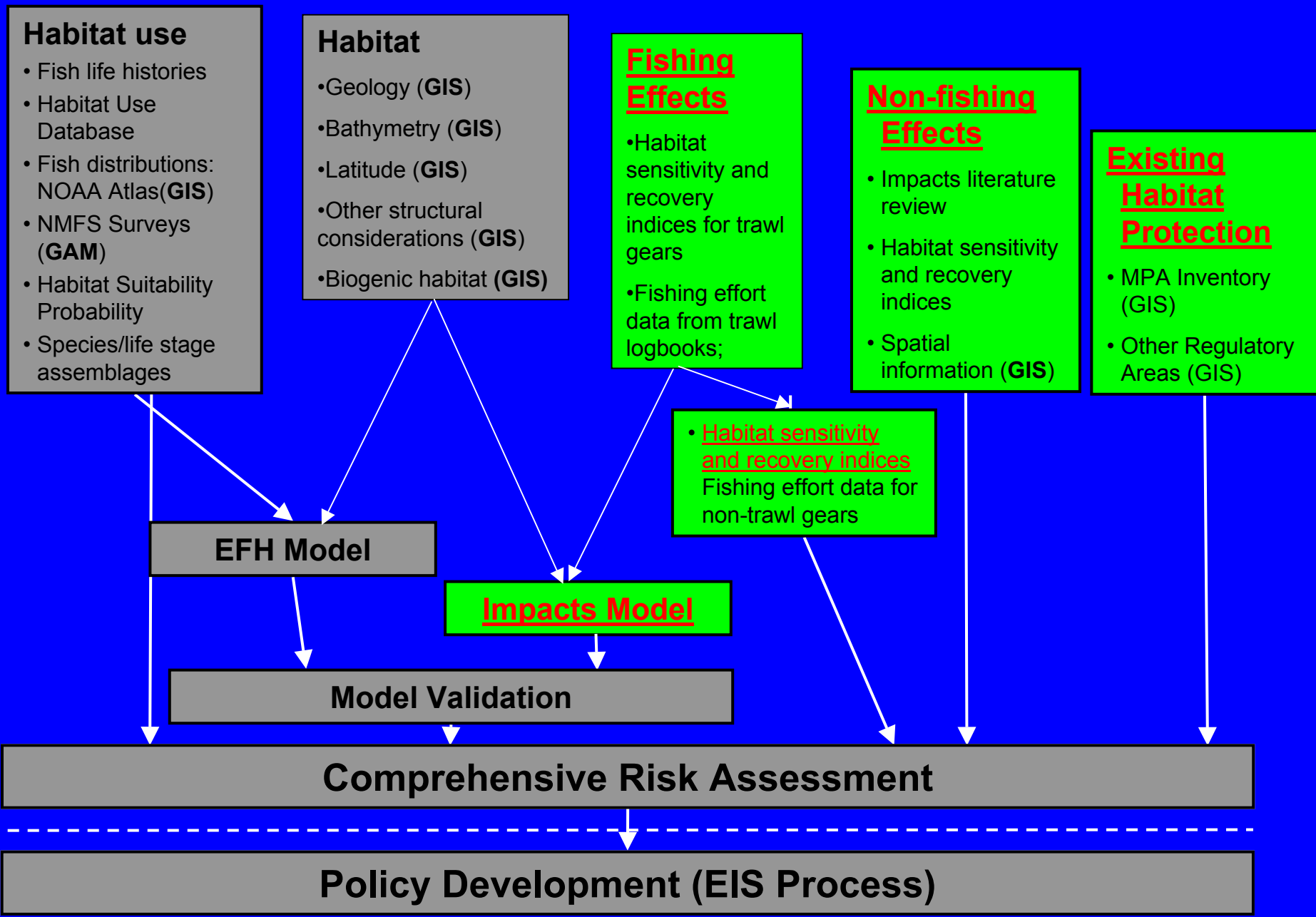
Decision-making Framework for EFH



Decision-making Framework for EFH



Decision-making Framework for EFH



Phased Approach to Public Assessment Process (1 of 3)

Initial Scoping (April, ’01 – Oct, ’01)

- NOI
- Public meetings
- Council splits EISs

Kick-off (Oct, 01 – April, ’02)

- New NOI
- NMFS internal EFH workshop drafts decisionmaking framework in March
- Council adopts framework at April mtg.

Phased Approach to Public Assessment Process (2 of 3)

Data Consolidation / Infrastructure Dev. (April '02 – Nov '02)

- PSMFC contracting
- Preliminary modeling
- Council forms TRC in November, 2002

Proof-of-Concept (Nov '02 – April, '03)

- TRC endorses preliminary approach in February
- Council comment in April

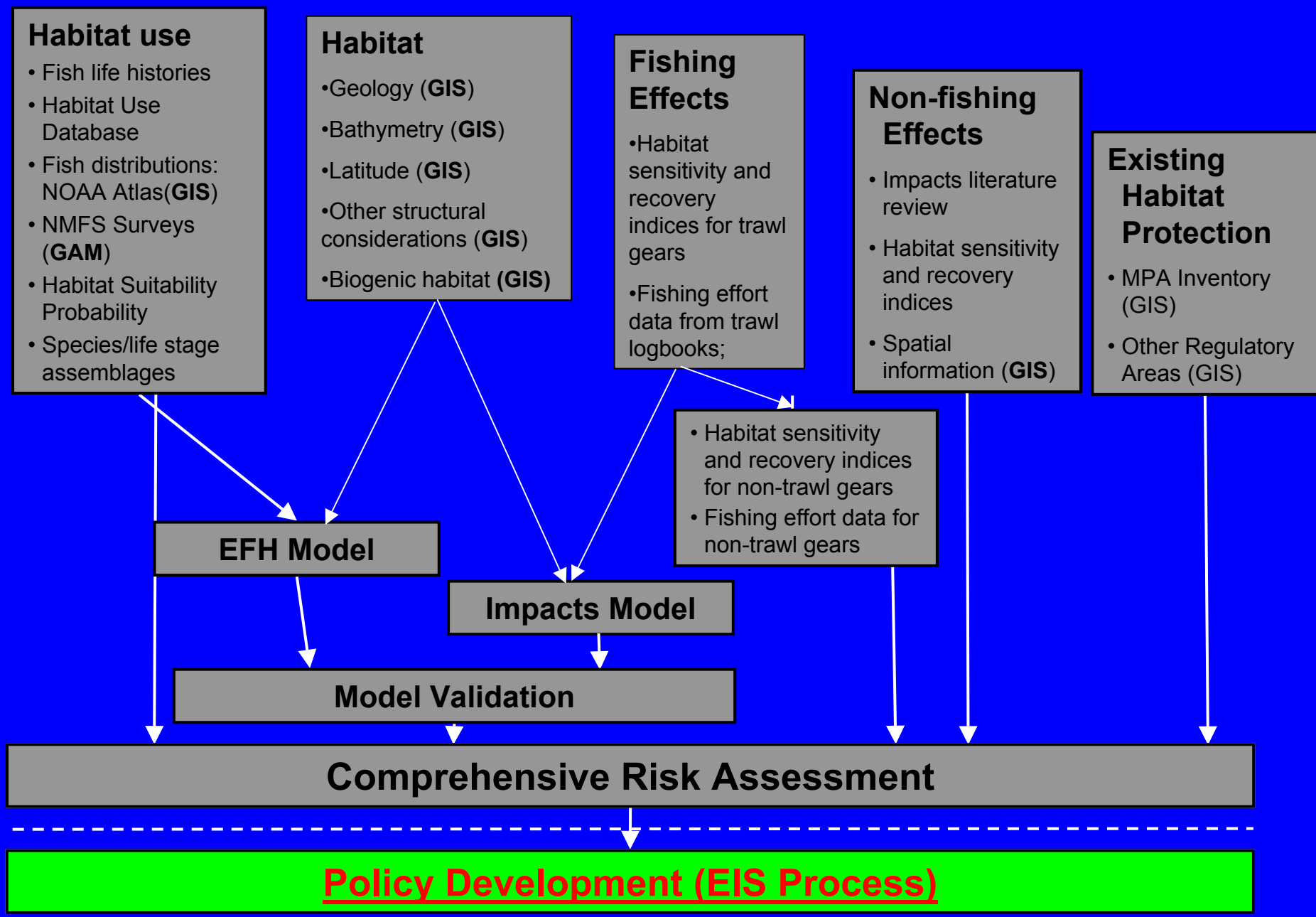
Phased Approach to Public Assessment Process (3 of 3)

Assessment and Review (April ’03 – June ’04)

- TRC meetings as “in-stream” check points in August and November
- SSC final review in February and May

Validation – (ongoing)

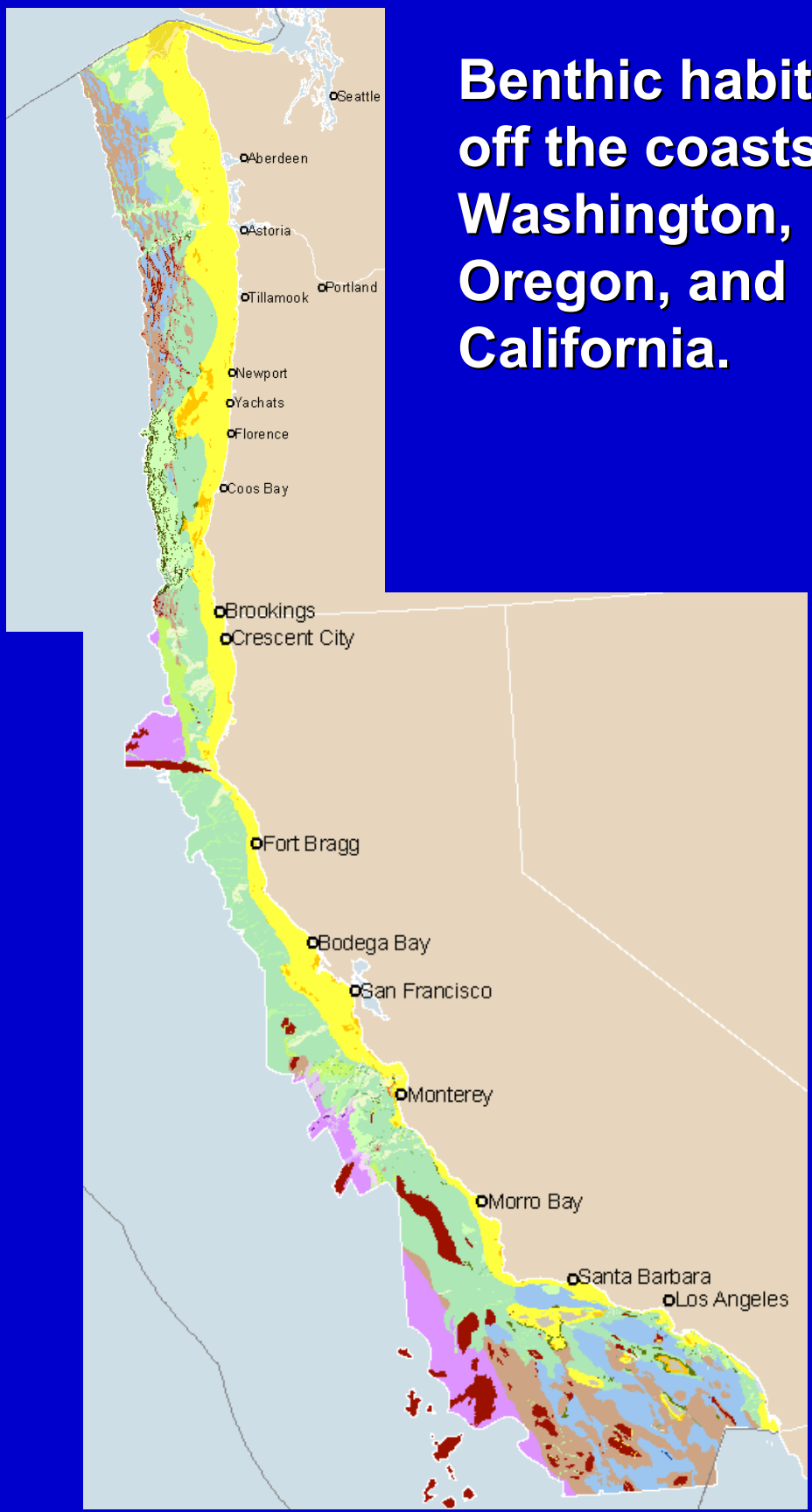
Decision-making Framework for EFH



The End

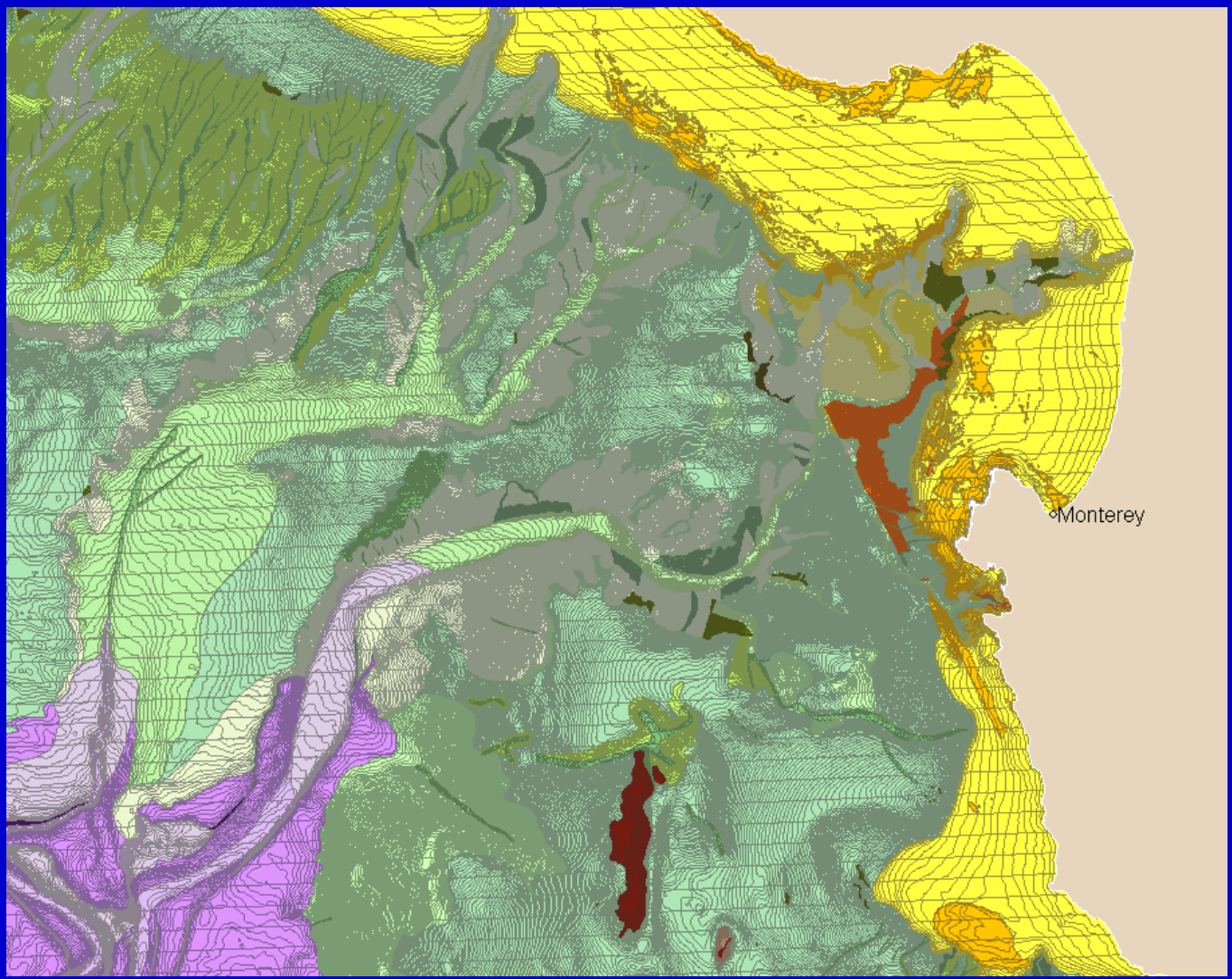
The End

Benthic habitat off the coasts of Washington, Oregon, and California.



TerraLogic GIS

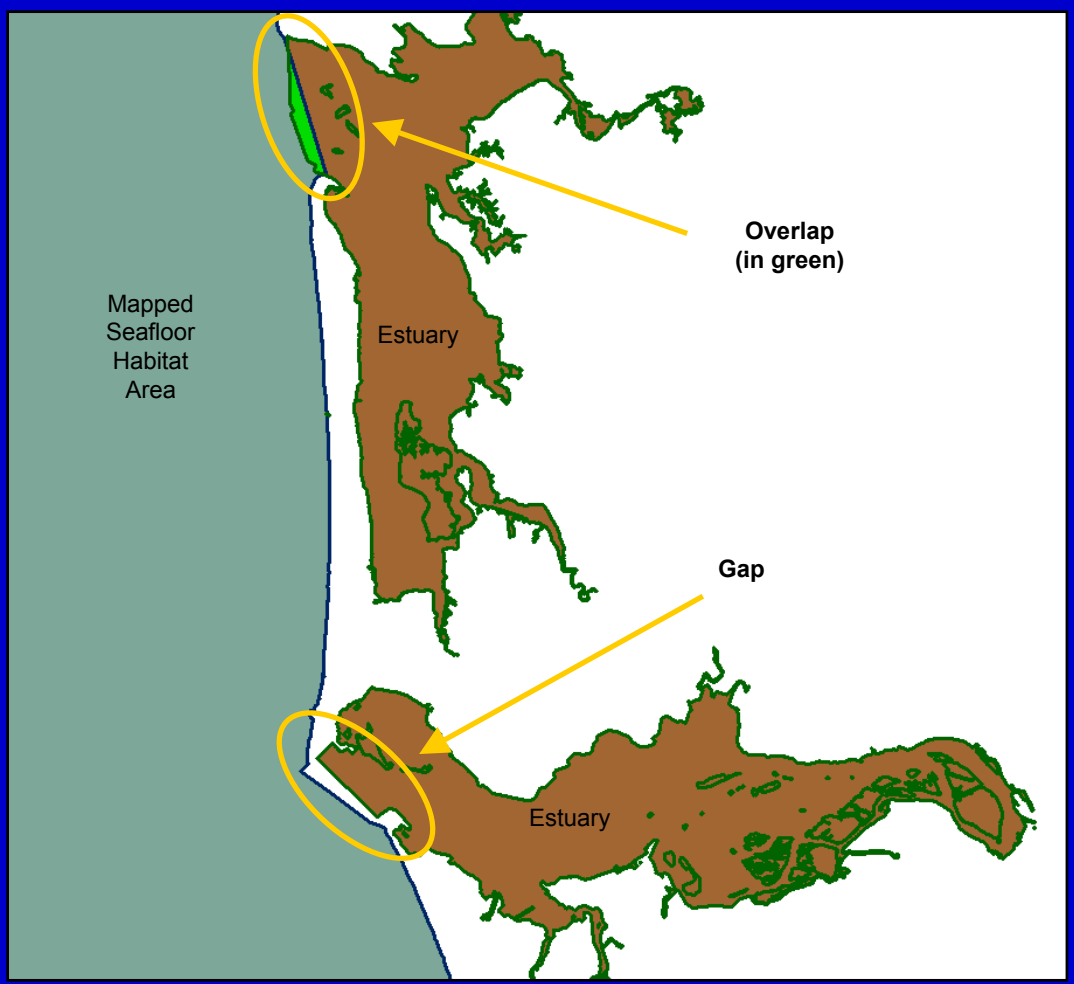
West Coast Habitat Polygons
(total = 973,165)



TerraLogic GIS

Estuaries

- Estuaries generally not mapped by marine geologists (a few exceptions)
- Used data from 1998 EFH project – original source: National Wetlands Inventory and NOS Coastal Assessment Framework
- Some overlap and some gaps between estuary boundaries and seafloor habitat maps
- Lacks associated seafloor habitat information

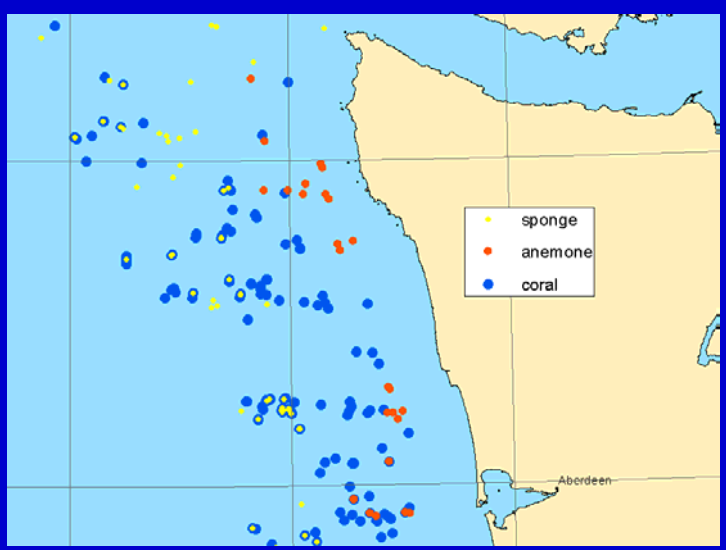


Biogenic Habitat

- Canopy kelp

- Seagrass

- Structure-forming invertebrates

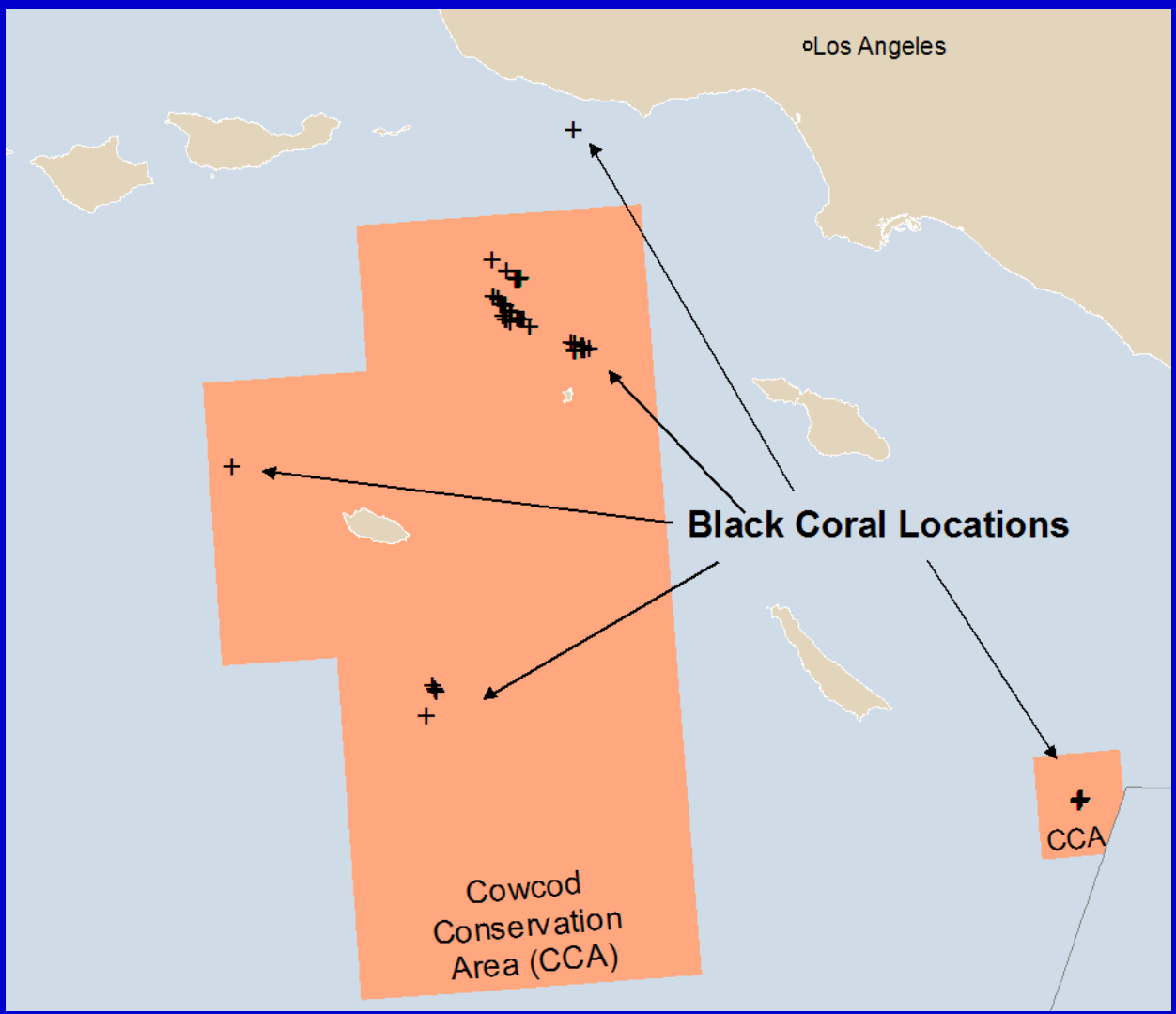


- Limited information is available to spatially delineate these biological habitats coastwide.
- incomplete coverage was preferable to leaving these data out of the GIS

TerraLogic GIS

Black Corals Dive Data

Data Source: Brian Tissot, WSU

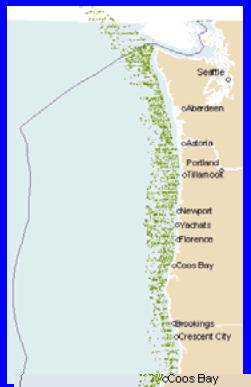


Pelagic Habitat

- Some species do not associate with the sea bed
- biological, physical and chemical oceanographic processes may be important for fish in the water column
- frontal boundaries, temperature regimes and biological productivity all vary on seasonal and inter-annual scales
- Impacts from non-fishing sources (e.g. pollution) may be significant
- Impacts from fishing gears likely to be minimal and temporary
- No attempt made to map pelagic habitat

Return

Data sources: Habitat Use

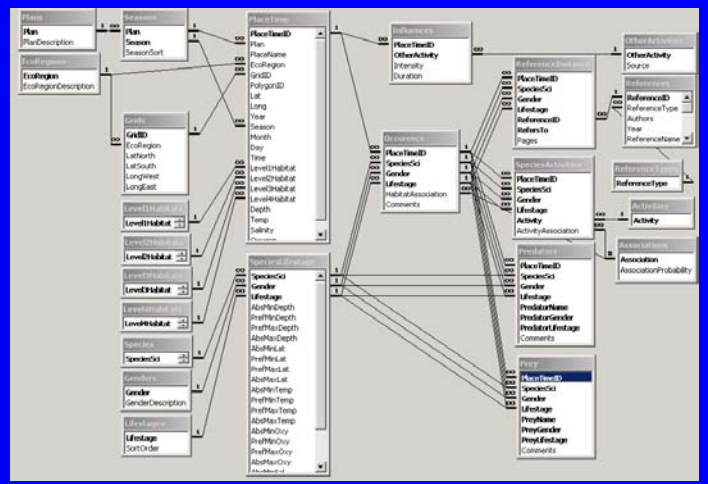


NMFS Surveys

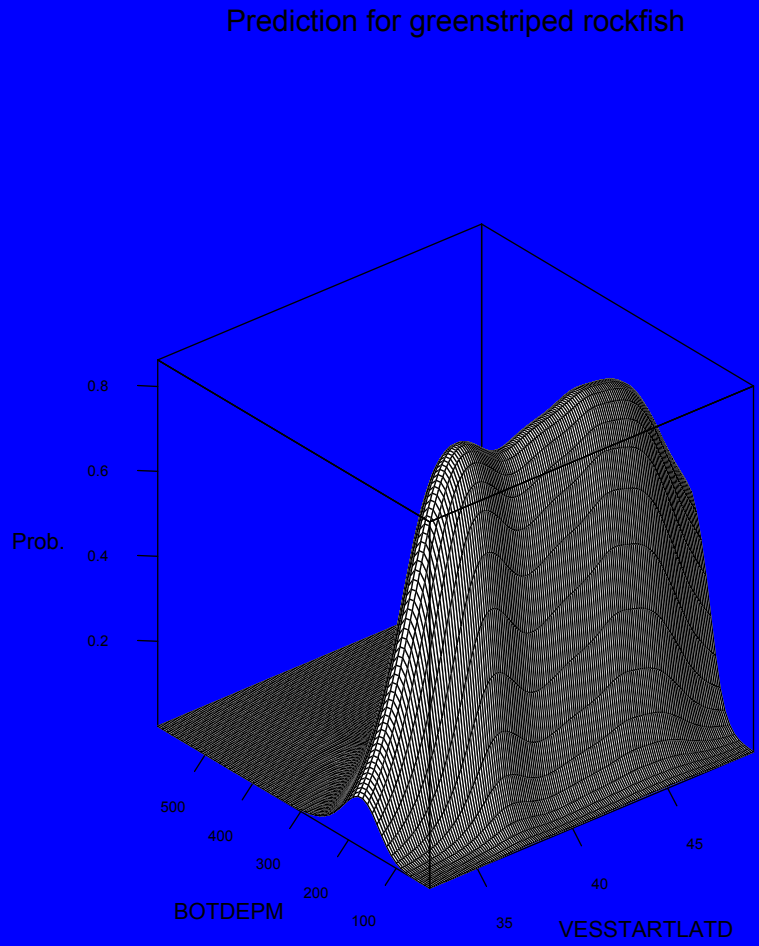
- 3 survey Series: AFSC Shelf and Slope, NWFSC Slope
- 1984 - present
- Bottom Trawl
  - Samples primarily adults
  - some areas unsampled due to habitat

Habitat Use Database

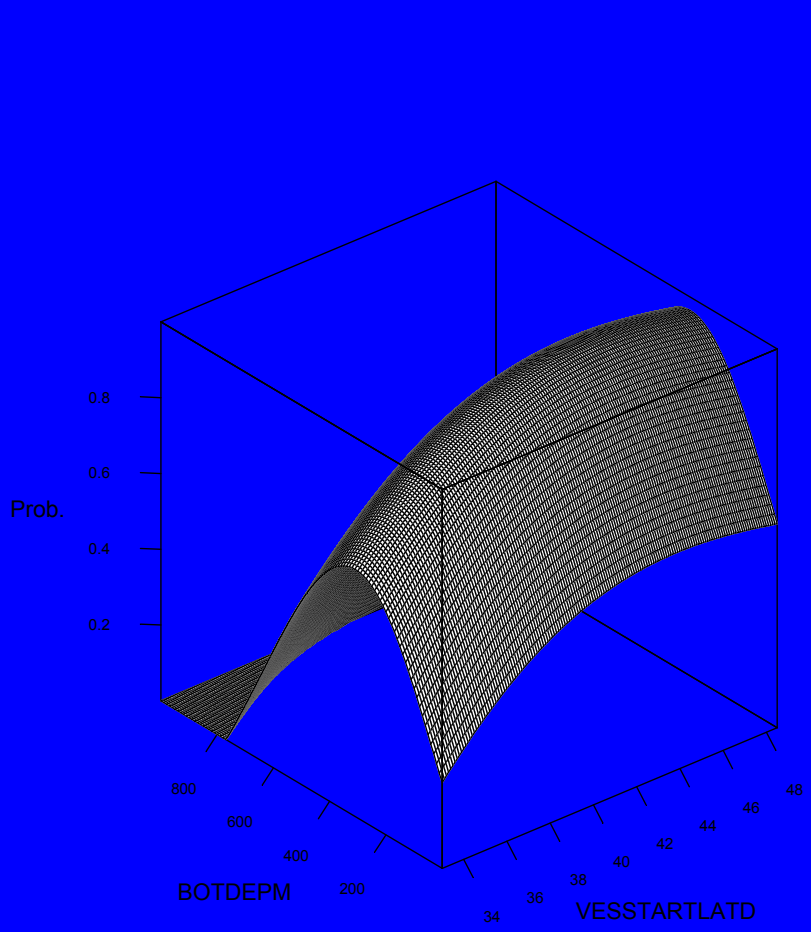
- Relational database of habitat use by species and life stage (MS Access 2000)
- Incorporates information in the Life Histories Appendix updated by Bruce McCain et al.
- Habitat classification (based on OLO)
- References



Final HSP Plots: Survey Data



HUD method: Result



Summary of Species/Life Stage Coverage

- Target = 82 species x 4 life history stages = 328
- All adult phases (100%)
- 48 juvenile stages (59%)
- 14 larval stages (17%)
- 12 egg stages (15%)
- Obtained = 156

		Level of Substrate information				Source of latitude and Depth Data			
	Common Name	Adults	Juveniles	Larvae	Eggs	Adults	Juveniles	Larvae	Eggs
1	Arrowtooth flounder	4	4	3	3				
2	Aurora rockfish	3	3	3					
3	Bank rockfish	4	4						
4	Big skate	4	3		4				
5	Black rockfish	4	4	3					
6	Black-and-yellow rockfish	4	4	3					
7	Blackgill rockfish	4	3	3					
8	Blue rockfish	4	4	3					
9	Bocaccio	4	4	4					
10	Bronzespotted rockfish	4	4						
11	Brown rockfish	4	4	3					
12	Butter sole	4	4	4	4				
13	Cabezon	4	4	3	4				
14	Calico rockfish	4	4	3					
15	California scorpionfish	4	4		3				
16	California skate	4	3		4				
17	Canary rockfish	4	4	3					
18	Chilipepper	4	4	4					
19	China rockfish	4	3	3					
20	Copper rockfish	4	4	4					
21	Cowcod	4	4	3					
22	Curlfin sole	4	4	3	3				
23	Darkblotched rockfish	4	4	3					
24	Dover sole	4	4	3	3				
25	Dusky rockfish	4	4						
26	English sole	4	4	3	3				
27	Finescale codling	2							
28	Flag rockfish	4	4	3					
29	Flathead sole	4	4	3	3				
30	Gopher rockfish	4	4	3					
31	Grass rockfish	4	4	3					
32	Greenblotched rockfish	4	4	3					
33	Greenspotted rockfish	4	4	3					
34	Greenstriped rockfish	4	4	3					
35	Harlequin rockfish	4	3	3					
36	Honeycomb rockfish	4	4						
37	Kelp greenling	4	4	3	4				
38	Kelp rockfish	4	4	4					
39	Leopard shark	4	2						
40	Lingcod	4	4	3	4				
41	Longnose skate	3	3		2				

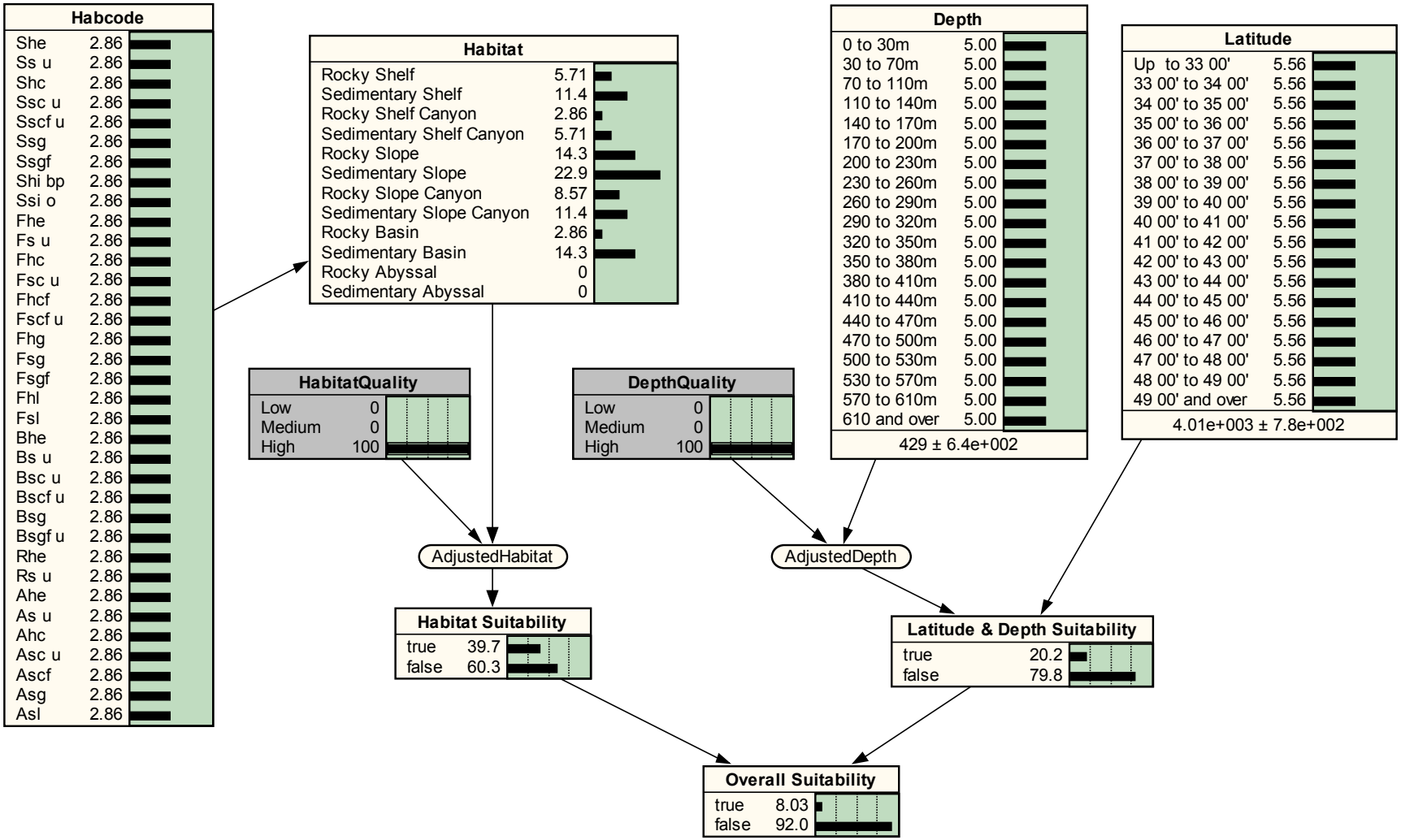
Survey	Survey+	HUD	Not done	No data
20	16	124	94	74

Return

EFH model: purpose

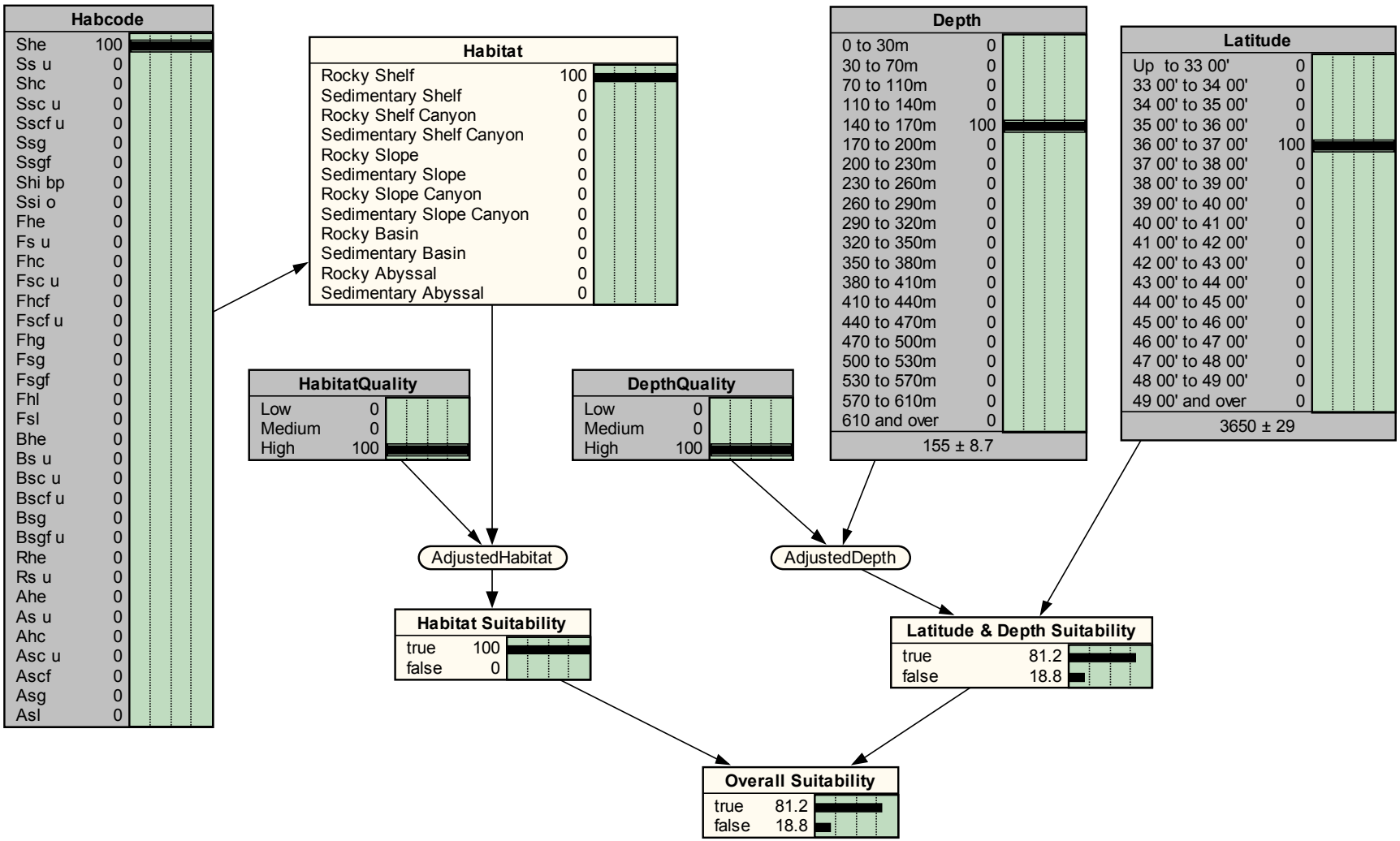
EFH is “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (M-S Act § 3(10)).

EFH Netica Model



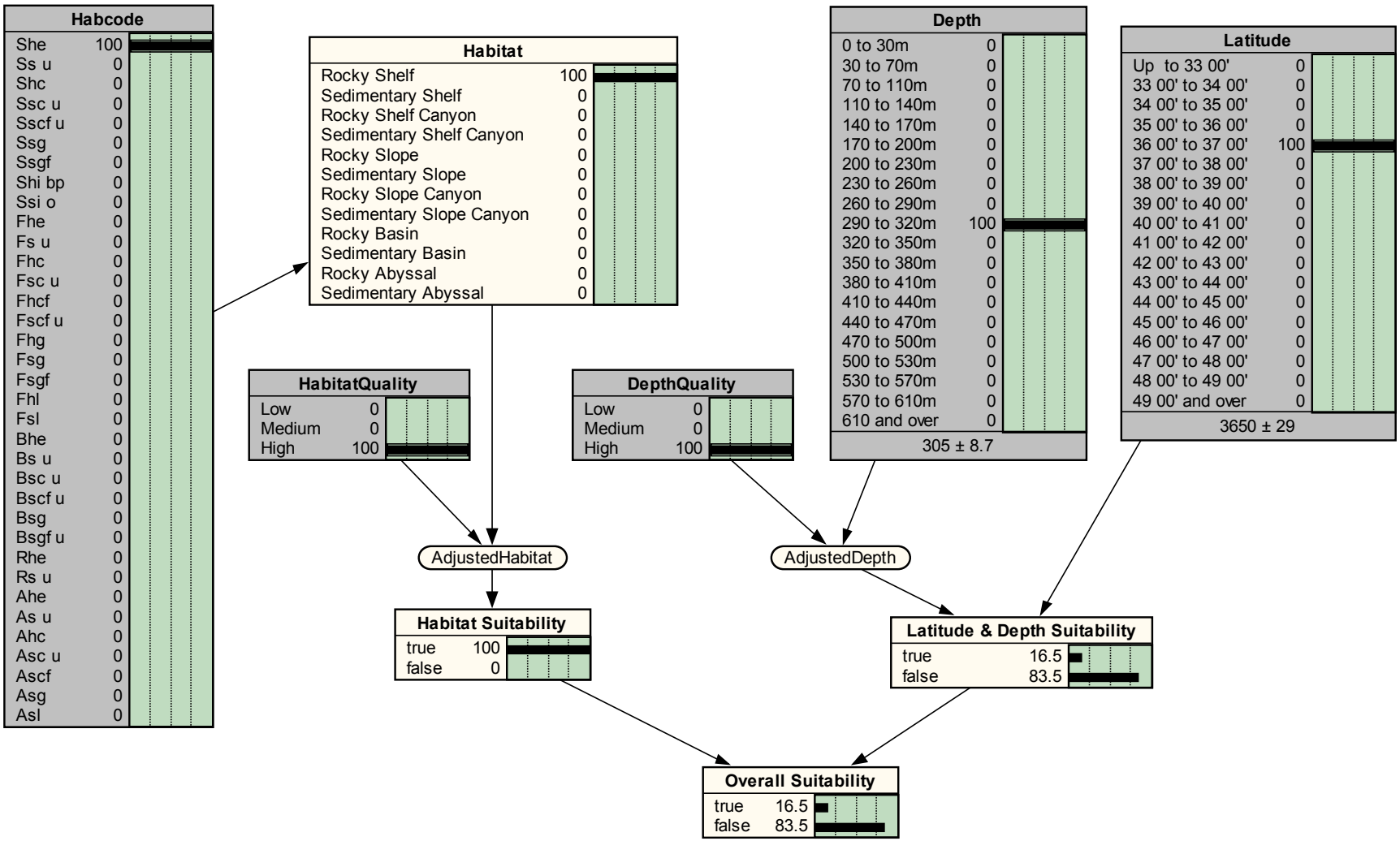
Greenstriped Rockfish Adults

Forward Inference



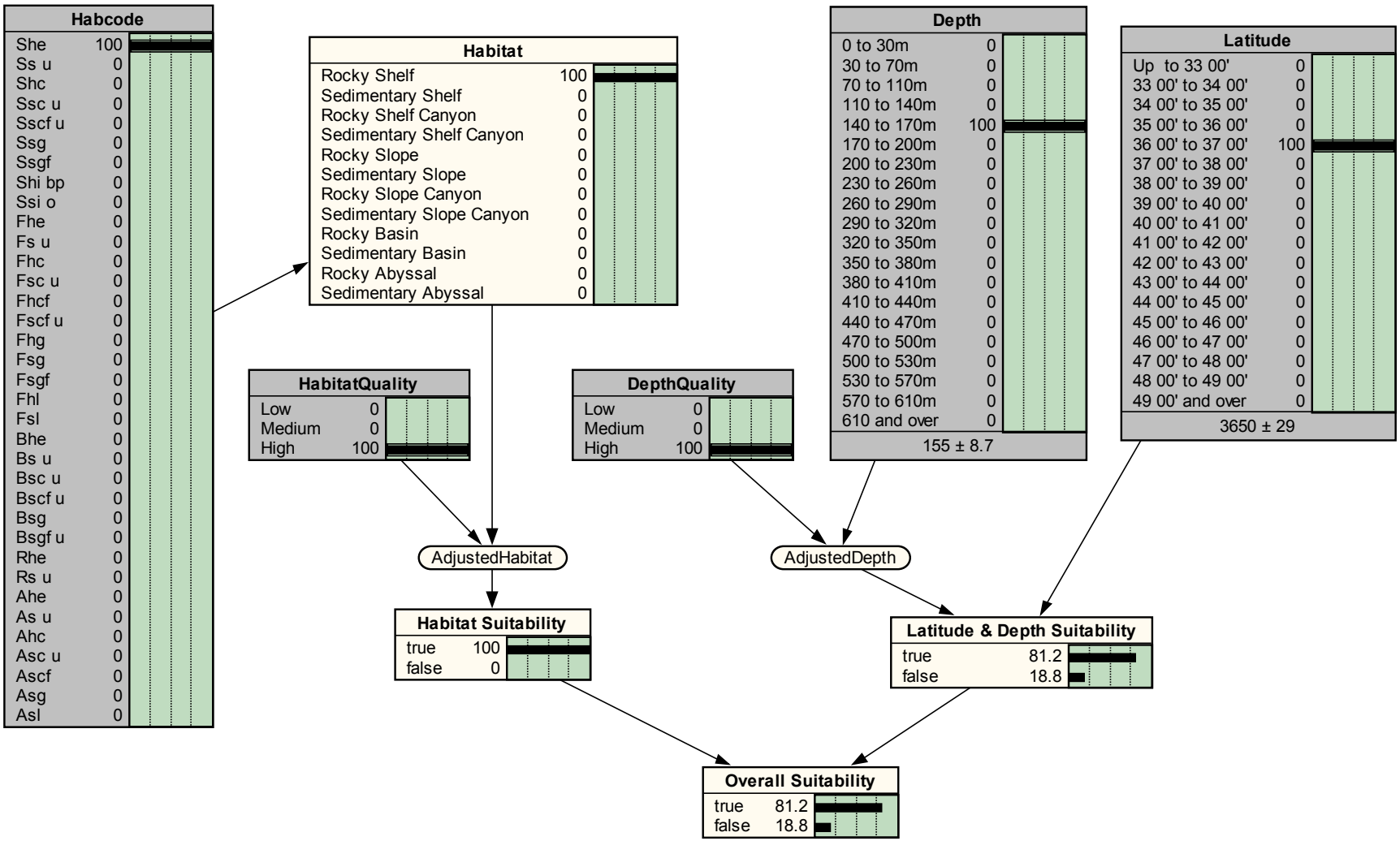
Greenstriped Rockfish Adults

Forward Inference: Deeper



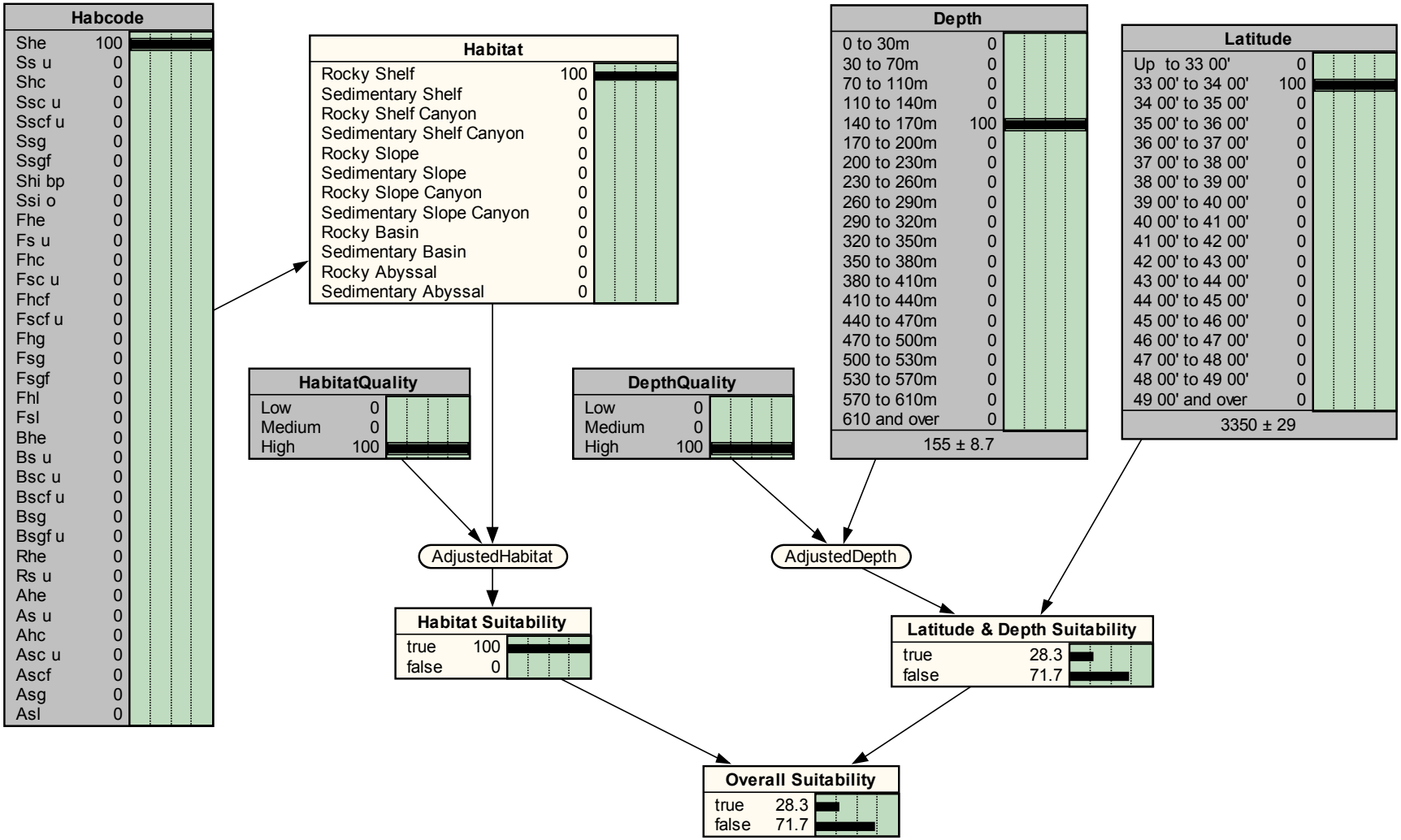
Greenstriped Rockfish Adults

Forward Inference



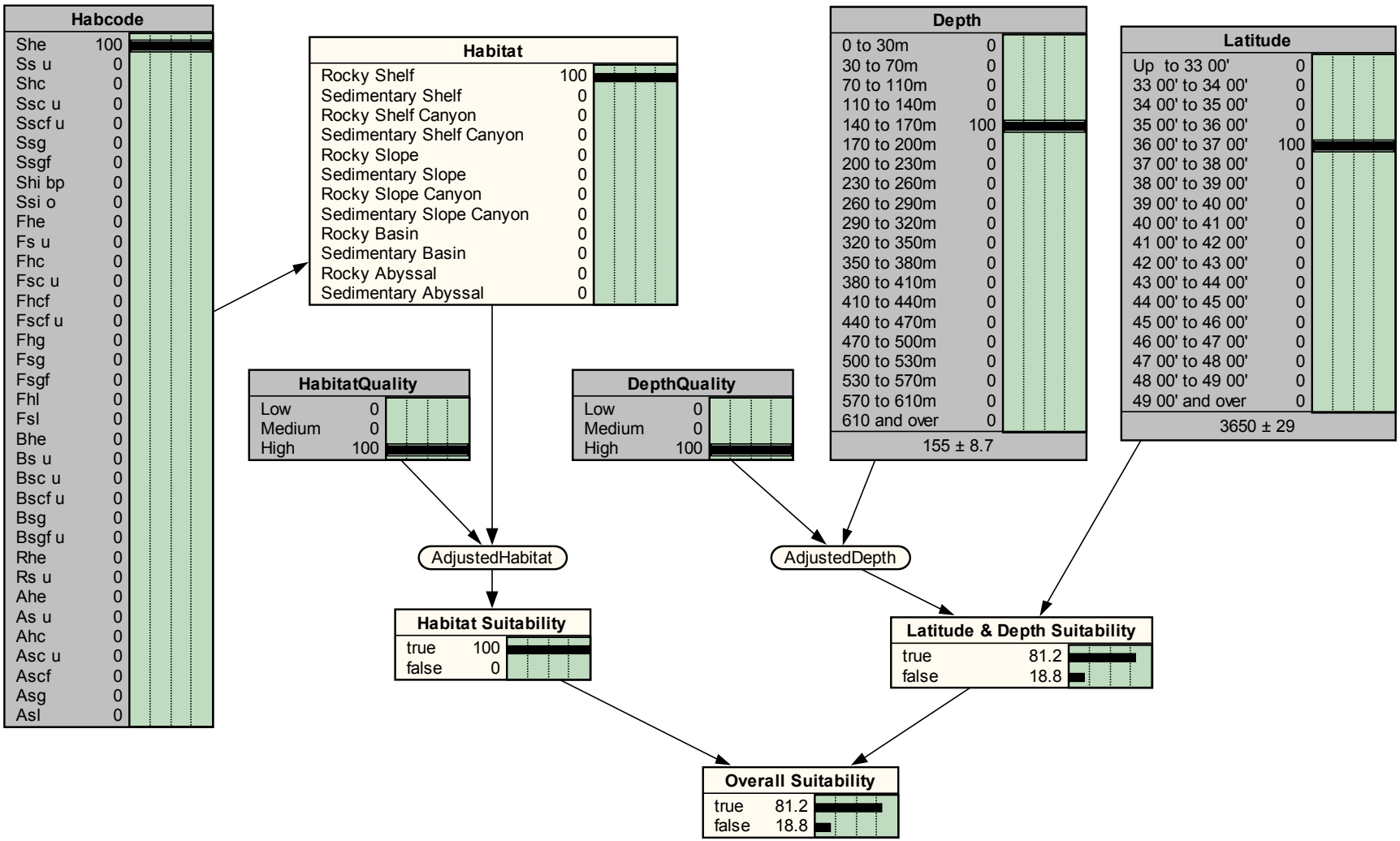
Greenstriped Rockfish Adults

Forward Inference: Further South



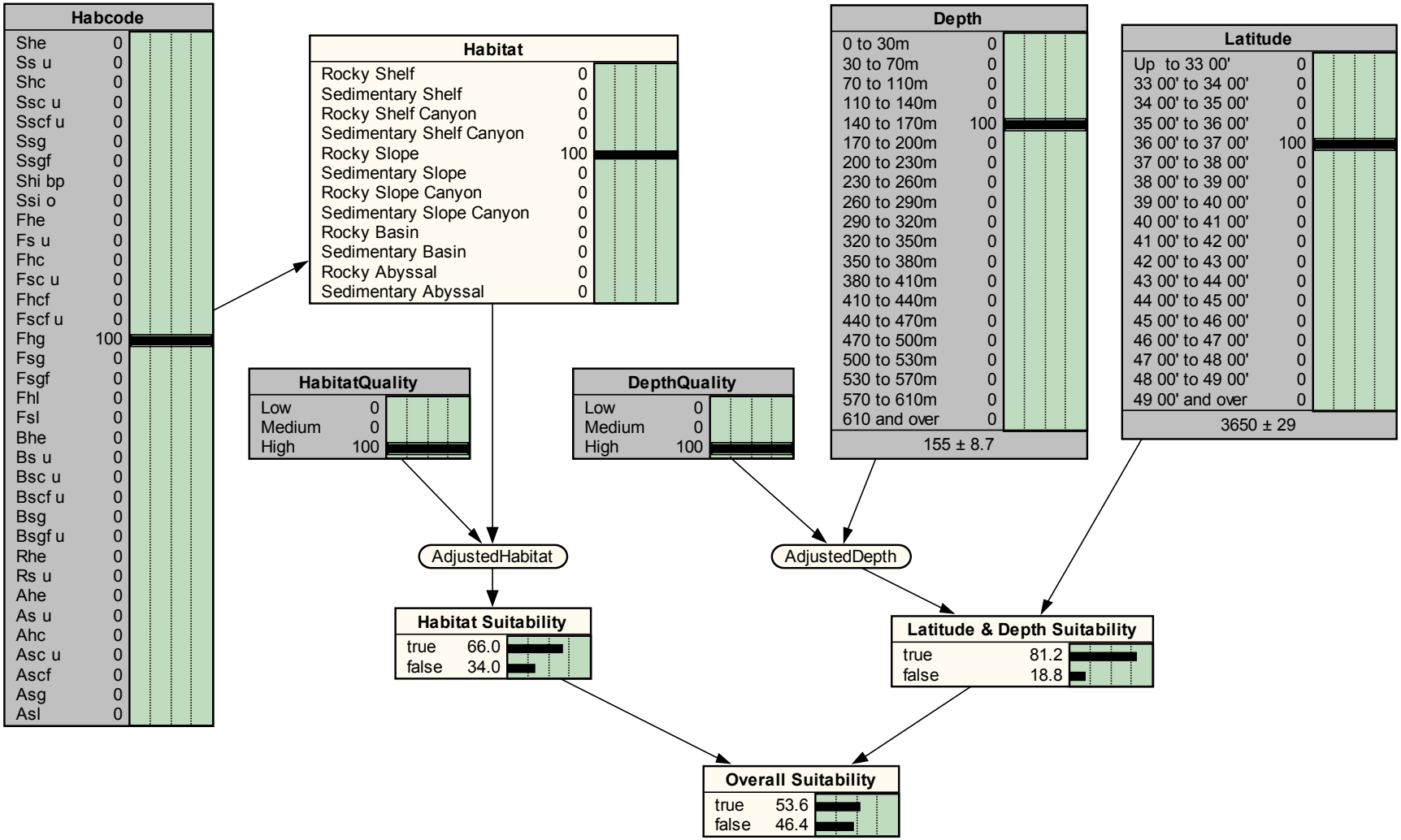
Greenstriped Rockfish Adults

Forward Inference



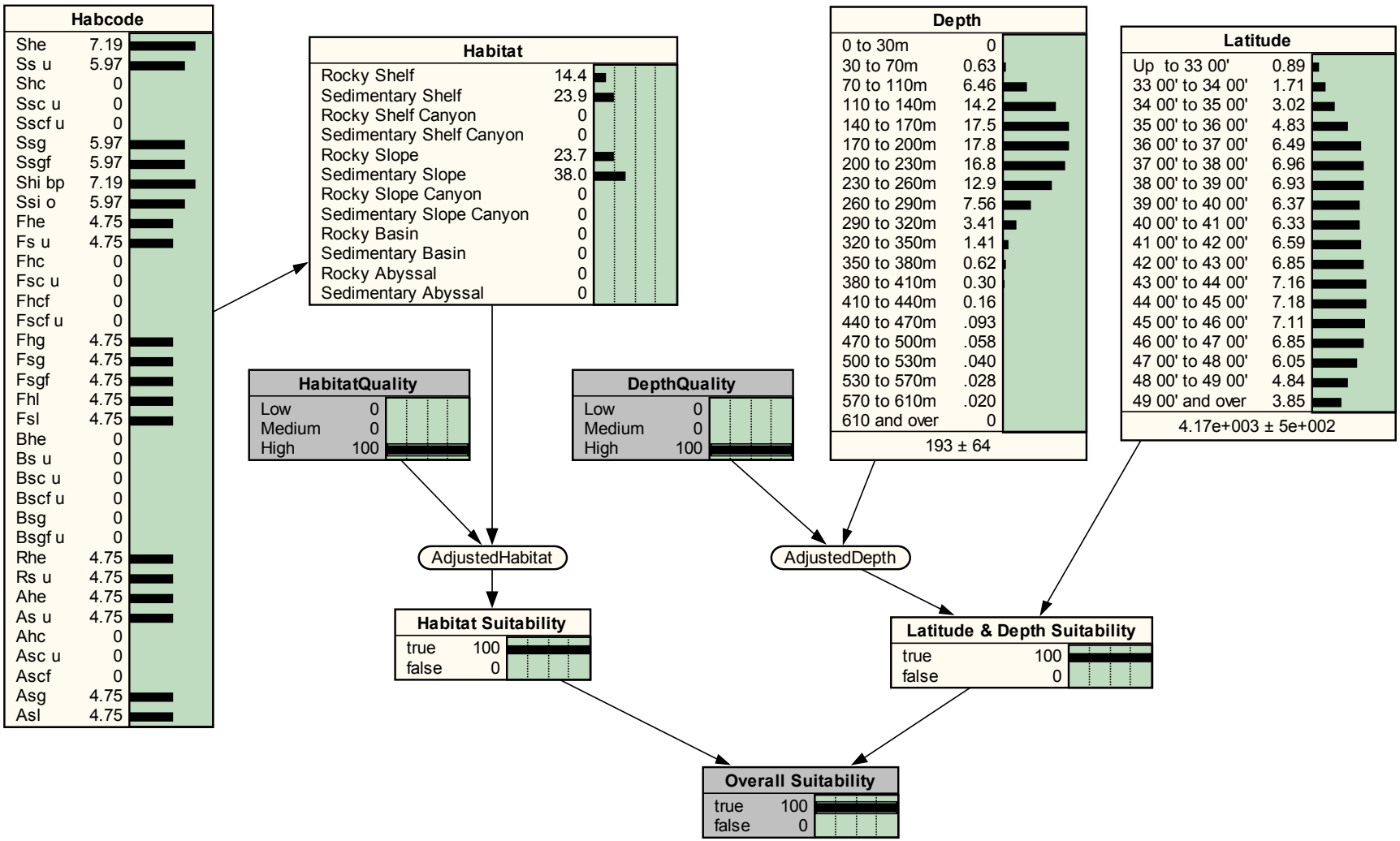
Greenstriped Rockfish Adults

Forward Inference: Different Substrate



Greenstriped Rockfish Adults

Backward Inference: Preferred Habitat

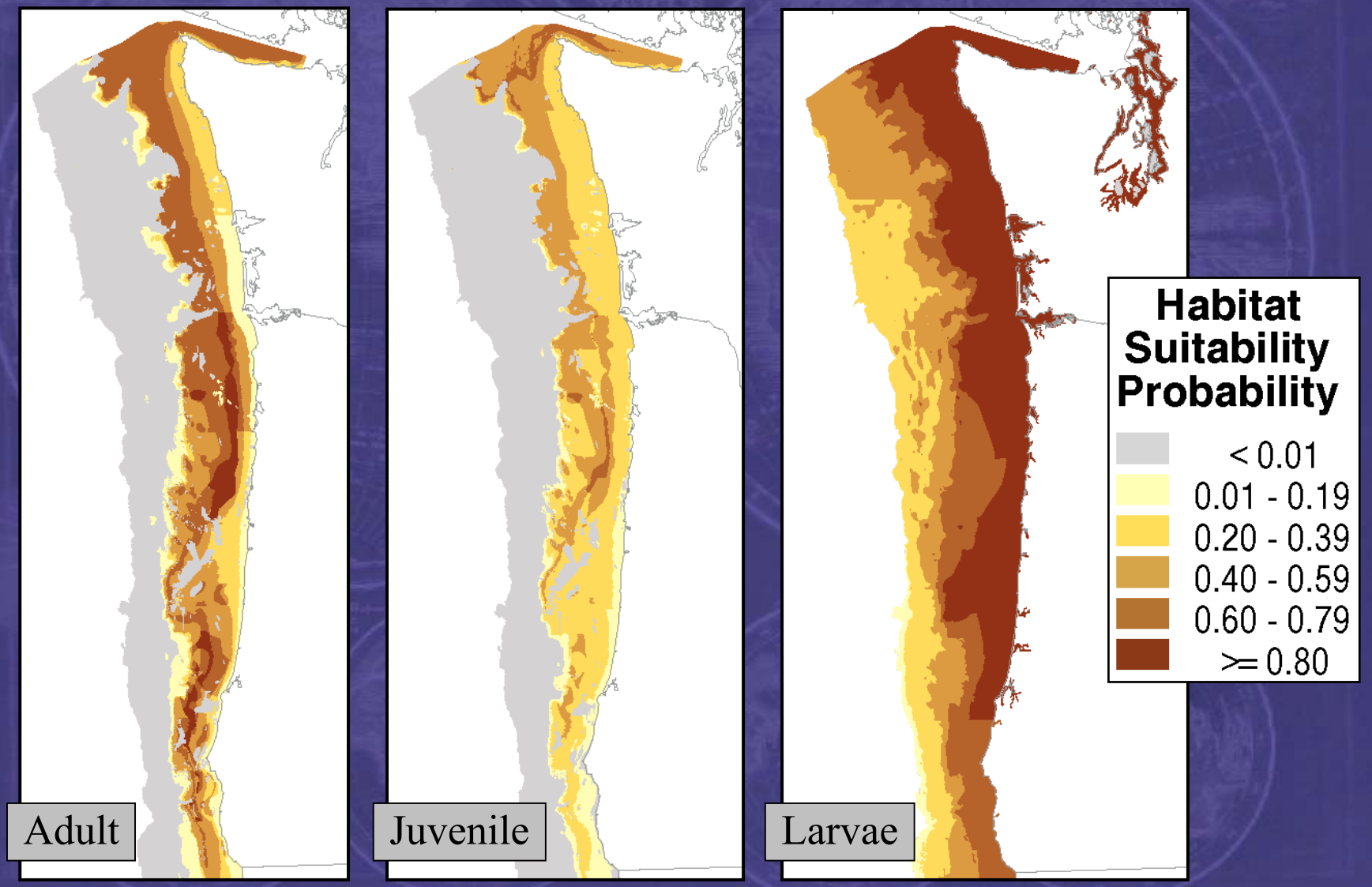


Greenstriped Rockfish Adults

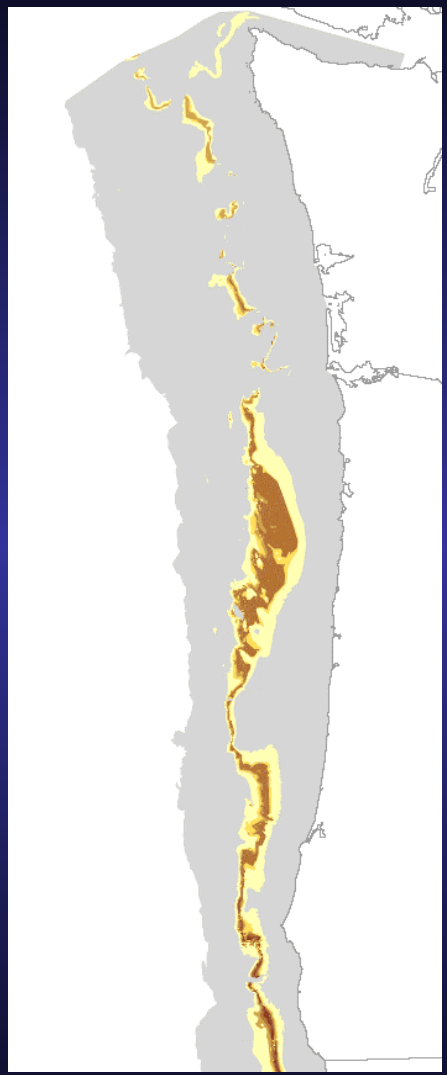
Return

BBN and GIS Integration: Single Species Mapping

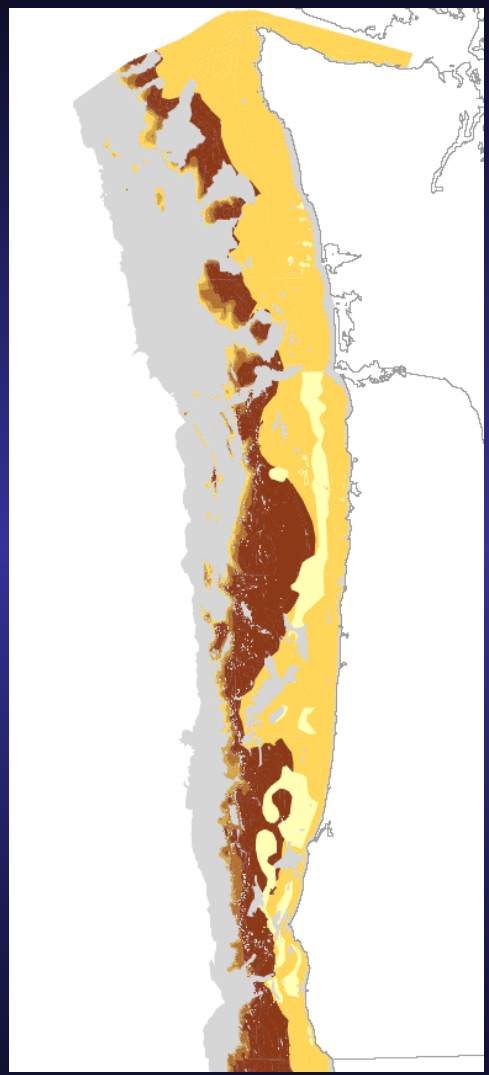
Arrowtooth Flounder



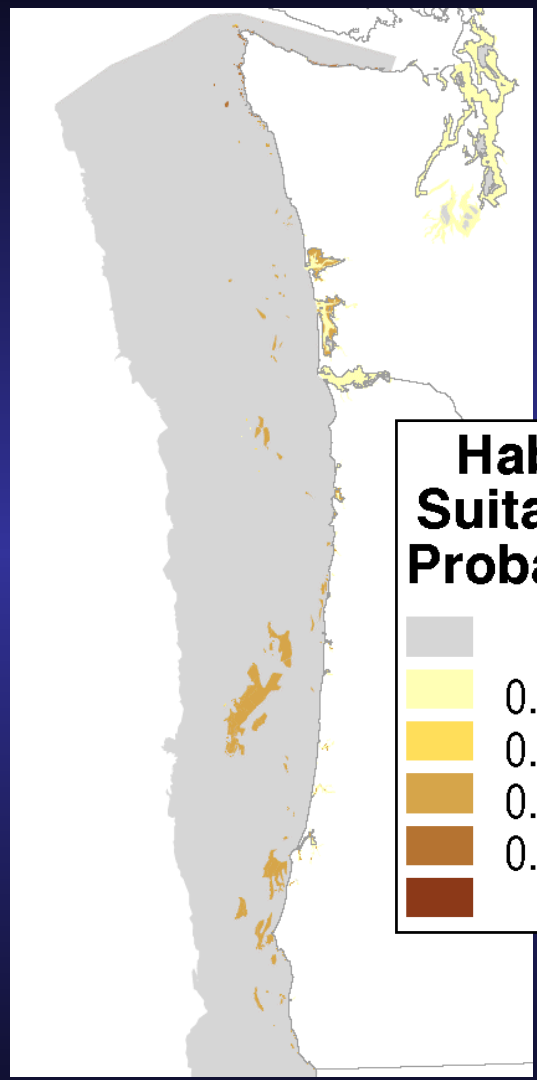
BBN and GIS Integration



Aurora rockfish Adults



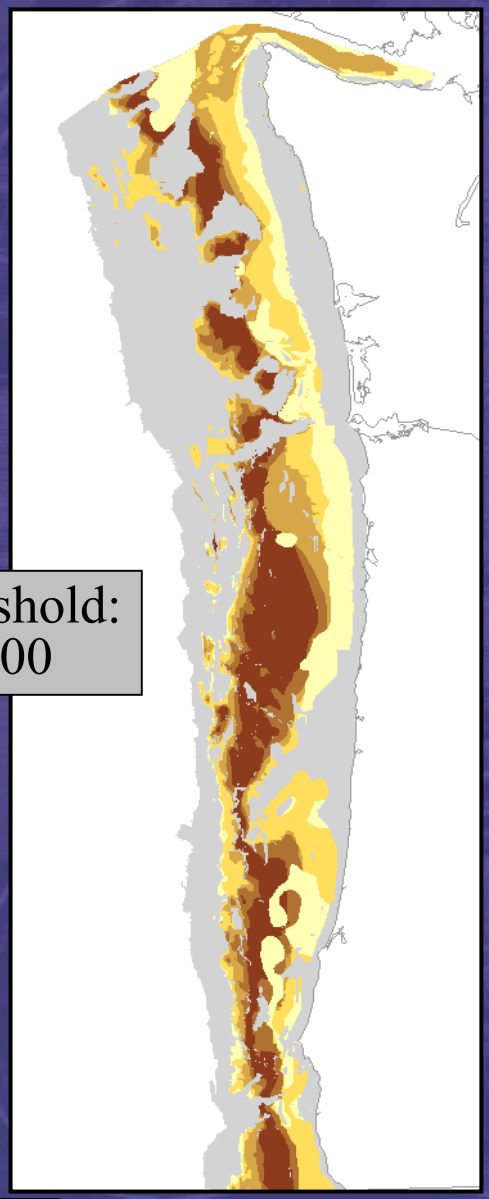
Dover sole Adults



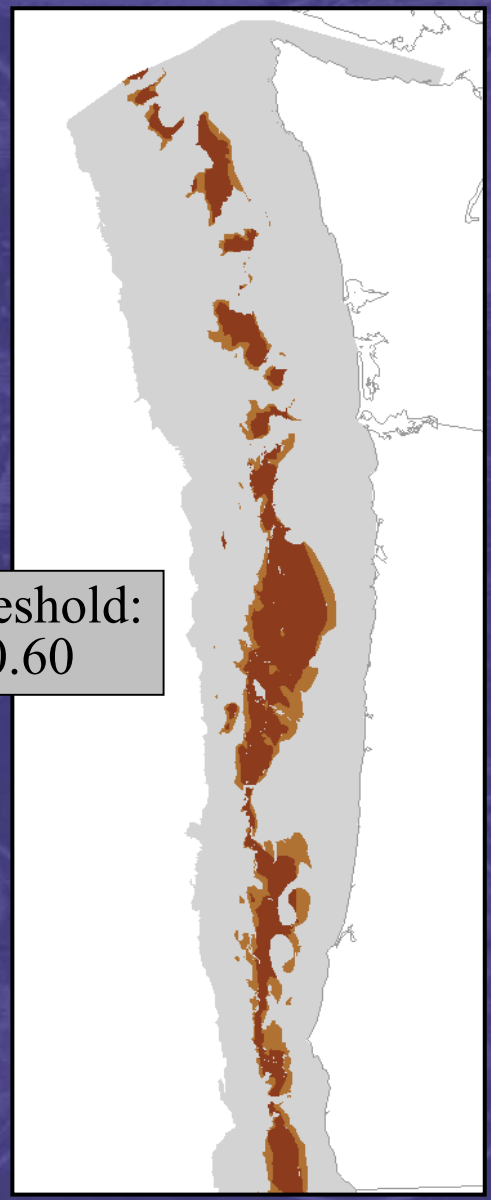
Lingcod Adults

Essential Fish Habitat GIS

BBN and GIS Integration: Mapping & HSP Threshold



Threshold:
0.00



Threshold:
0.60

Shortspine Thornyhead

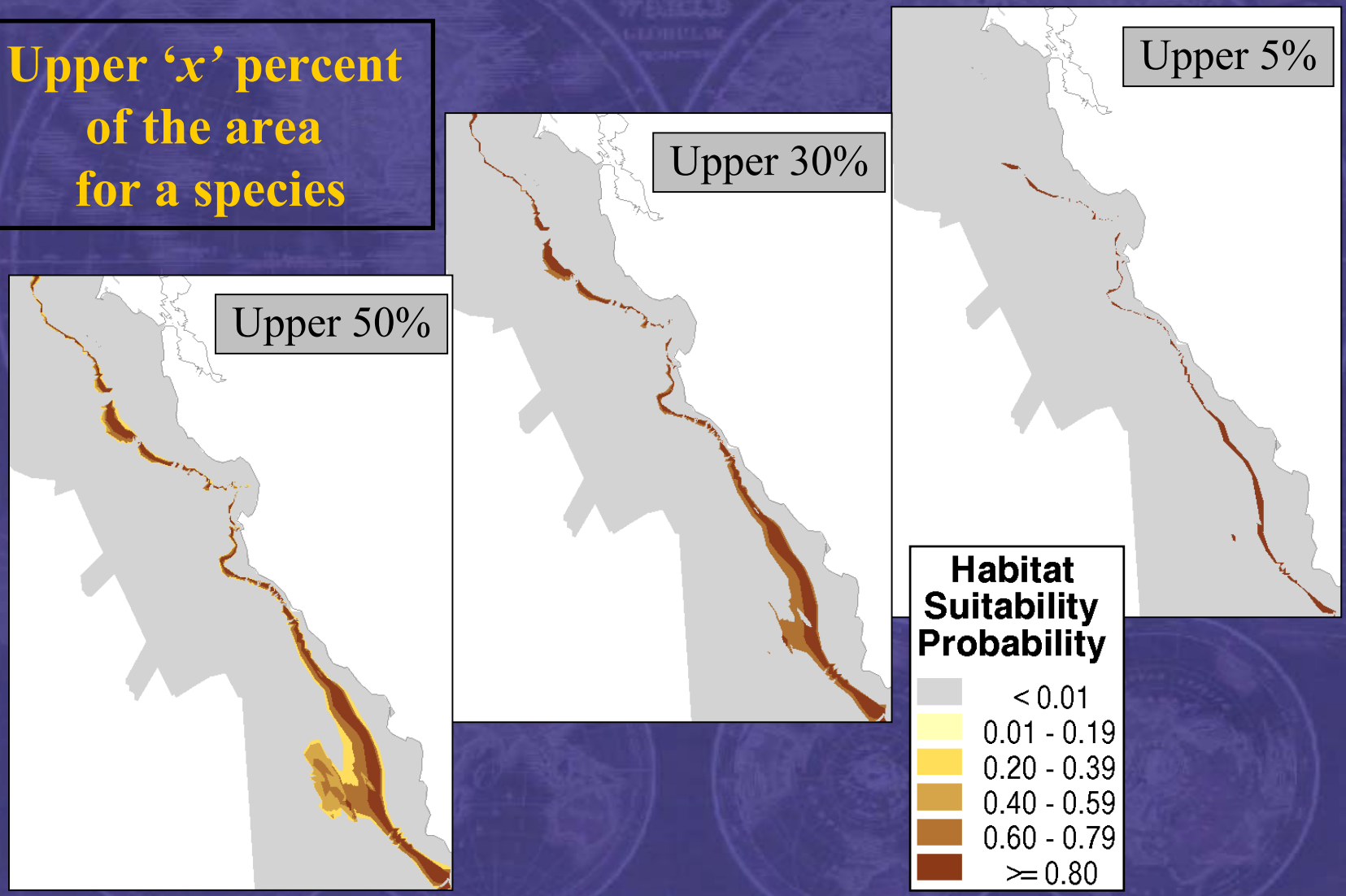
Habitat Suitability Probability

- < 0.01
- 0.01 - 0.19
- 0.20 - 0.39
- 0.40 - 0.59
- 0.60 - 0.79
- >= 0.80

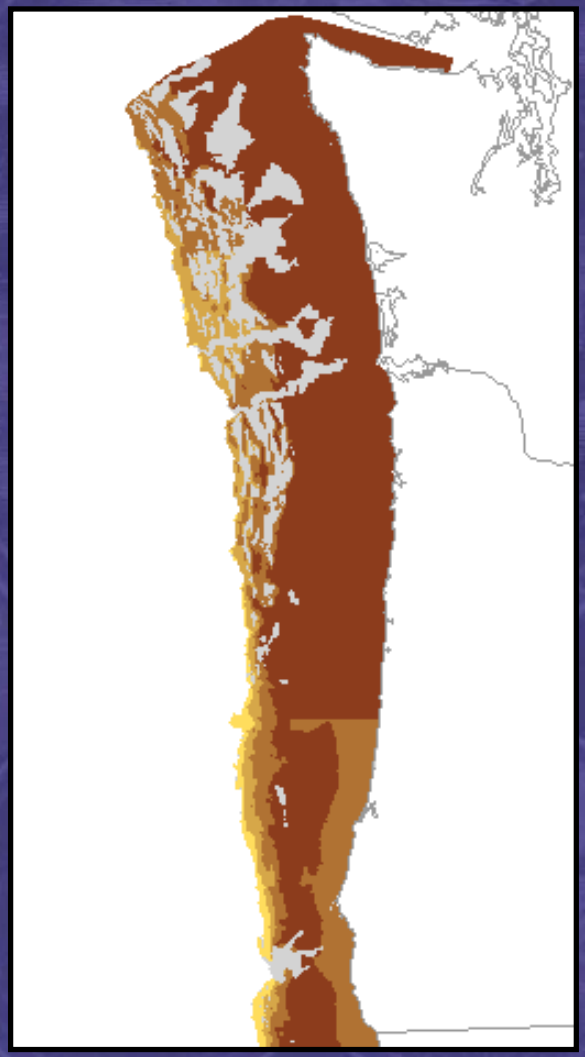
BBN and GIS Integration: Area Threshold

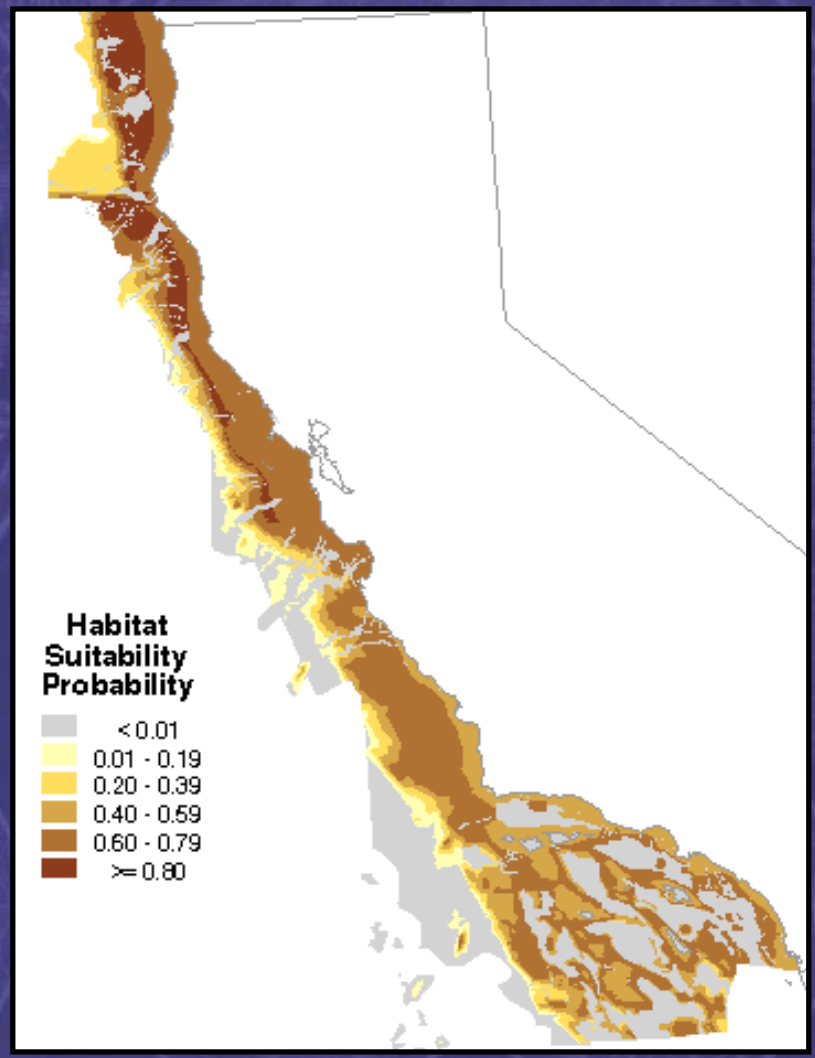
Aurora Rockfish

Upper '*x*' percent of the area for a species



BBN and GIS Integration: Species Groups
Slope Assemblage – Adult (HUD), Maximum HSP





Return

Fishing Effects

1. Sensitivity and recovery indices.

2. Effort location data.

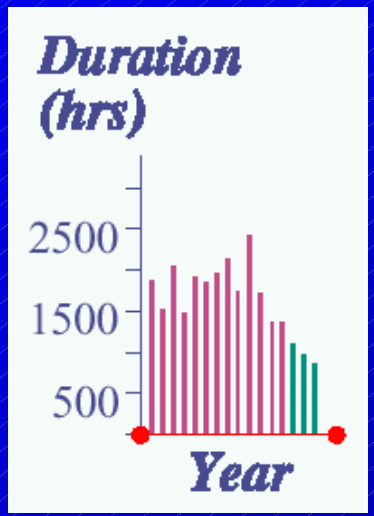
Sensitivity Levels and Recovery Time

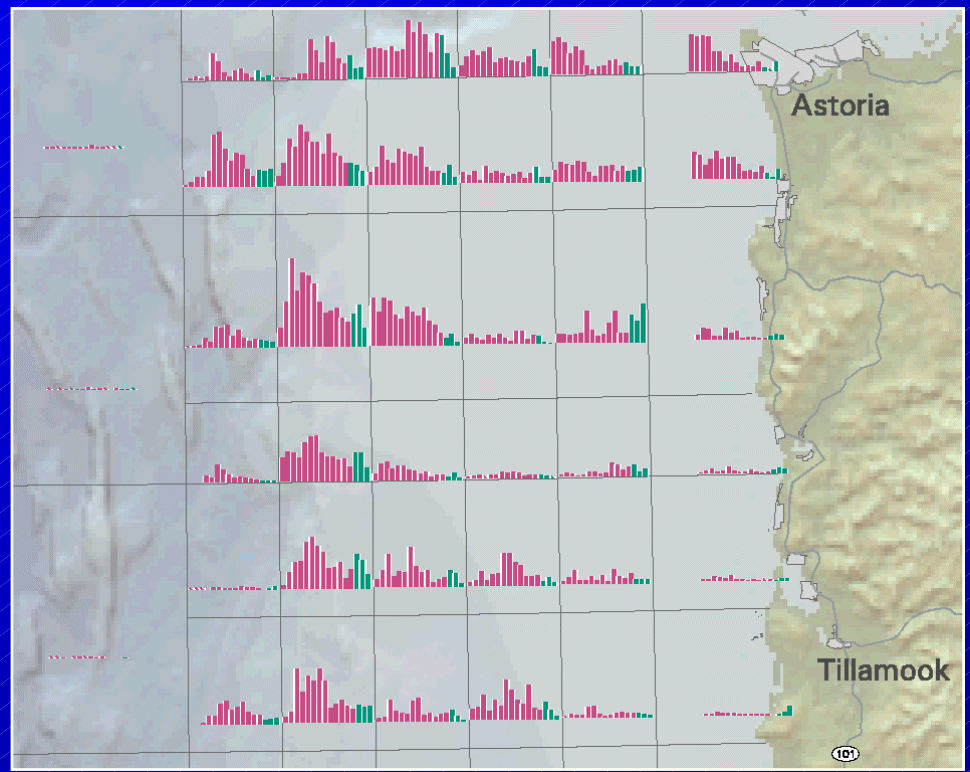
Sensitivity Level	Sensitivity Description
0	No detectable adverse impacts on seabed; i.e. no significant differences between impact and control areas in any metrics.
1	Minor impacts such as shallow furrows on bottom; small differences between impact and control sites, <25% in most metrics measured.
2	Substantial changes such as deep furrows on bottom; differences between impact and control sites 25 to 50% in most metrics.
3	Major changes in bottom structure such as re-arranged boulders; large losses of many organisms with differences between impact and control sites >50% in most metrics.

Recovery Time (yrs)	Recovery Description
0	No recovery time required because no detectable adverse impacts on seabed.
n	n=years required for impact sites to return to pre-impact condition; i.e. no significant differences between impact and control sites in any metrics measured.

Final Input to Impacts Model

We chose to represent the effort data on a grid of dimensions of the order of two average trawl lengths 10-minute by 10-minute areas





Return

West Coast Perspective on Non-Fishing Impacts: Development of Draft Index of Adverse Effects

Helvey et al. (2003) Non-Fishing Activities Reviewed…

Upland: Agricultural/Nursery Runoff; Timber Harvest; Pesticide Application; Urban/Suburban Development; Road Building & Maintenance

Riverine: Mineral Mining; Sand and Gravel Mining; Organic Debris Removal; Inorganic Debris Removal; Dam Operation; Commercial & Domestic Water Use

Estuarine: Dredging; Disposal of Dredged Material; Fill Material; Vessel Operation/Transportation/Navigation; Introduction of Exotic Species; Pile Driving; Pile Removal; Over-water Structures; Flood Control/Shoreline Protection; Water Control Structures; Log Transfer Facilities; Utility Lines/Cables/Pipeline Installation

Coastal and Marine: Point Source Discharges; Fish Processing Waste; Water Intake Structure/Discharges; Oil/Gas Exploration/Development/Production; Habitat Restoration/Enhancement; Marine Mining; Persistent Organic Pollutants

West Coast Perspective on Non-Fishing Impacts: Development of Draft Index of Adverse Effects

Table 1. Levels of impacts (direct and indirect adverse effects and their descriptions) for non-fishing activities on EFH functions of bottom habitats. (19 Feb 04)

Direct and Indirect Effects	
Level of Impact	**Description/Rules for Assigning Levels**
0	No detectable direct or indirect adverse effects on EFH functions would be expected.
1	Minor impacts that potentially only affect fish or benthos in short-term manner. Minor or no impacts on physical structure of habitat. Recovery of EFH functions likely in months to a few years if activity ceased.
2	Moderate impacts that potentially kill fish and benthos, and cause some changes in physical structure of habitat. Recovery of EFH functions likely within several years if activity ceased.
3	Major impacts that potentially kill fish and benthic fauna, and cause serious alterations in physical structure of habitat. Recovery of EFH functions not likely unless restoration efforts conducted, or will require many years if activity ceased.

West Coast Perspective on Non-Fishing Impacts:

Development of Draft Index of Adverse Effects

Table 2. Classification by location (Upland, Riverine, etc), descriptions, and impact levels for non-fishing activities that impact bottom habitats (from Boland et al. 2003). "Direct effects" are short-term (seconds to hours) responses to the activity or

Upland	Description	Impact Level
Agricultural/Nursery Runoff	Direct effects: nutrient enrichment, sedimentation, salt loading ==> increased turbidity and salinity, altered physiological (e.g. photosynthesis) and ecological (e.g. predation) rates	1
	Indirect effects: algal blooms, excessive oxygen fluctuations, decreased benthic invertebrate diversity and production, decreased fish growth and production	
Silviculture/Timber Harvest	Direct effects: sedimentation, salt loading, altered hydrological regime, increased stream temperature ==> algal blooms, excessive oxygen fluctuations, increased turbidity, altered physiological (e.g. photosynthesis) and ecological (e.g. predation, fish m	1
	Indirect effects: decreased benthic invertebrate diversity and production, decreased fish growth and production	
Pesticide Application	Direct effects: toxic responses by plants, invertebrates, and fish ranging from sublethal (e.g. altered respiration) to lethal	2
	Indirect effects: decreased habitat value (e.g. loss of macrophytes, temperatures exceed tolerances of some fish), decreased invertebrate diversity and production and fish growth and production	
Urban/Suburban Development	Direct effects: loss of riparian vegetated habitat, polluted runoff from altered and impervious surfaces, altered and polluted groundwater seepage ==>	3
	Indirect effects:decreased benthic invertebrate diversity and production, decreased fish growth and production	
Road Building and Maintenance	Direct effects: sedimentation, altered temperature regimes, migration barriers, altered hydrological regime, introduction of non-native species ==> increased turbidity, altered physiological (e.g. photosynthesis) and ecological (e.g. predation) rates, los	1
	Indirect effects: decreased benthic invertebrate diversity and production, decreased fish growth and production	

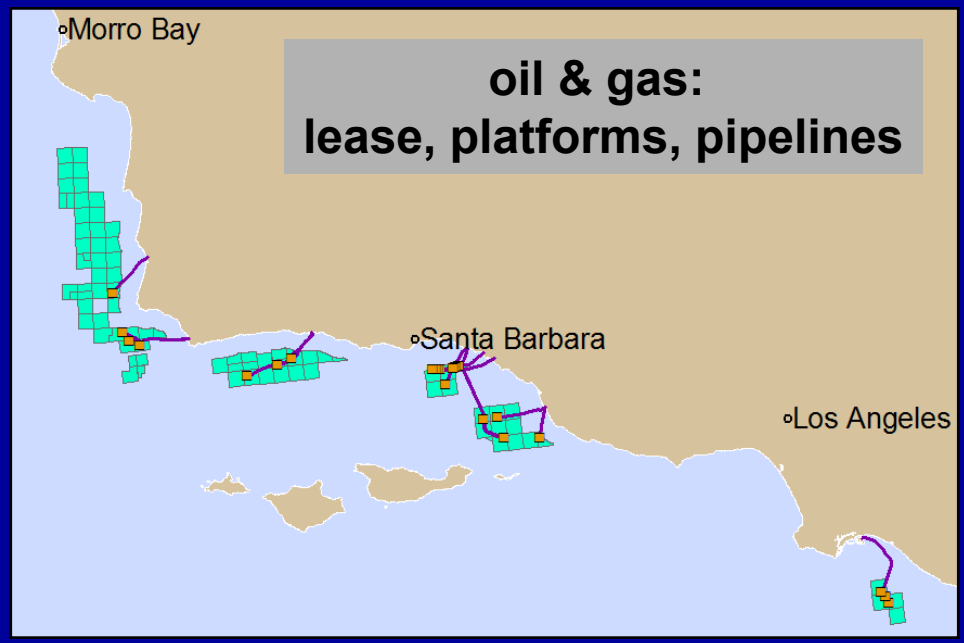
West Coast Perspective on Non-Fishing Impacts:

Development of Draft Index of Adverse Effects

Table 3. Draft index of impact levels for non-fishing activities by megahabitat/substrate/macrohabitat (Greene et al. 1999) for Upland, Riverine, Estuarine, and Coastal and Marine locations. Ranges were assigned as + ("Max") or - ("Min") 50% of the impac

		Upland Activities									
MEGAH X SUBSTRATE X MACROH	Habitat Code	Agricultural/ Nursery Runoff		Silviculture/ Timber Harvest		Pesticide Application		Urban/Suburban Development		Road Building & Maintenance	
Estuarine (0-10+ m water depth)		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Estuarine, Hard		0.5	1.5	0.5	1.5	1.0	3.0	1.5	3.0	0.5	1.5
Estuarine, Soft Sediment		0.5	1.5	0.5	1.5	1.0	3.0	1.5	3.0	0.5	1.5
Estuarine, Biogenic		0.5	1.5	0.1	1.5	1.0	3.0	1.5	3.0	0.5	1.5
Shelf (10 to 200 m water depth)											
Shelf, Hard, Exposed	She	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Soft Sediment	Ss_u	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Hard, Canyon Wall	Shc	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Soft Sediment, Canyon Wall	Ssc_u	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Hard, Canyon Floor		0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Soft, Canyon Floor	Ssc/f_u	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Hard, Gully	Shg	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Soft, Gully	Ssg	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Hard, Glacial Pavement	Shi_b/p	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Soft, Glacial Outwash	Ssi_o	0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9
Shelf, Biogenic		0.2	0.9	0.2	0.9	0.8	2.0	0.9	2.1	0.2	0.9

Non-Fishing Impacts Data: Examples



Non-Fishing Impacts Data Collection

Data Collected :

Upland – USGS Land Use-Land Cover (1993) – coastwide

Riverine – Dam Locations – coastwide

Estuarine - Disposal of Dredged Material – Gray's Harbor, WA

Overwater Structures (marinas only) – WA, CA

Shoreline Protection – WA, CA

Aquaculture (approval level) – coastwide

Coastal and Marine –

Water Intake Locations – CA

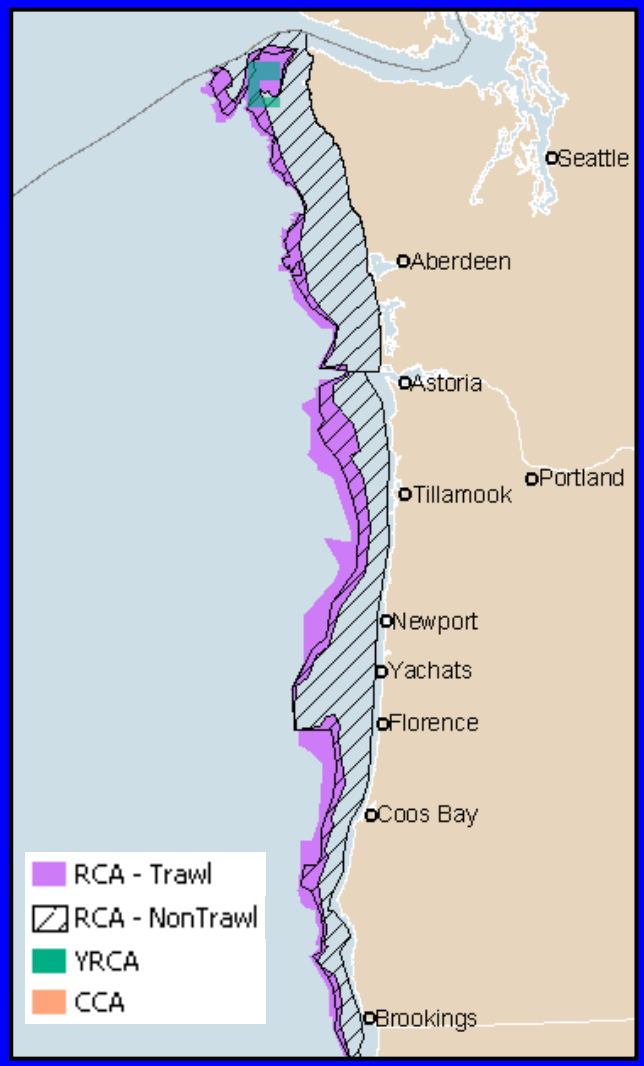
Cable Locations/Pipelines – WA, OR

Oil/Gas -- Leases, Platforms, and Pipelines – coastwide

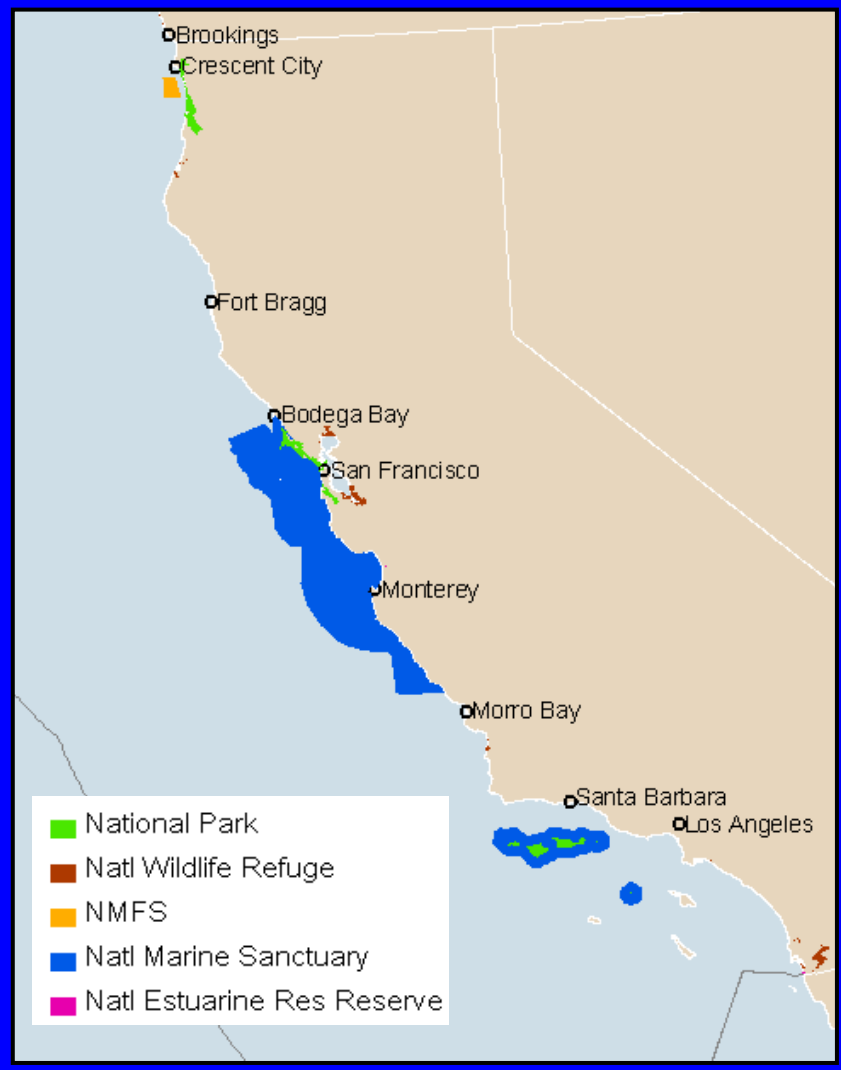

Return

Existing Marine Management Areas

Federal Fishing Regs.



Federal MMA



TerraLogic GIS

Return

Recap on Action Needed

". . . must act to prevent, mitigate, or minimize any adverse effects from fishing, **to the extent practicable**, that is more than **minimal** and not **temporary** in nature.

Impacts Model

Questions to be Answered:

- what is the probability that habitat has been impaired by past activities?
- are there definable areas at risk?
- are there foreseeable trends?
- can we manage those trends?
- What are the scientific limitations of assessing habitat?

Impacts Model

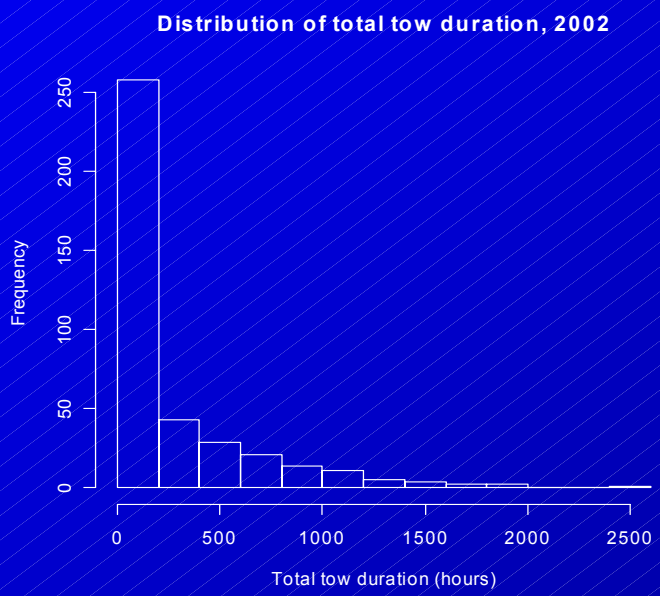
Impact depends on:

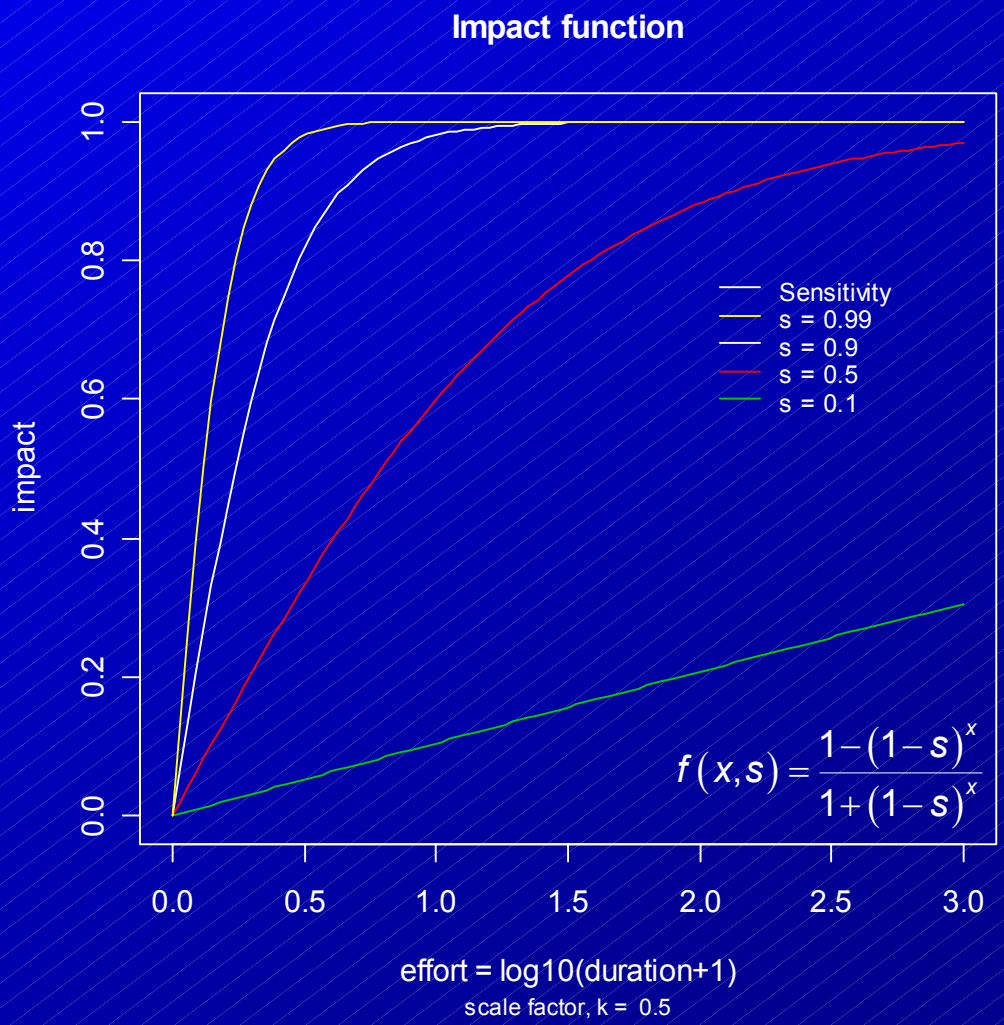
- *fishing effort* (by gear)
- *sensitivity* (by gear and habitat) and
- *recovery* (by gear and habitat).

Impact Function

For a given area,we measure *Impact* on a scale of 0 to 1

- 0 represents pristine
- 1 represents maximally changed from pristine – i.e. the maximum amount of change that a particular gear type can cause.





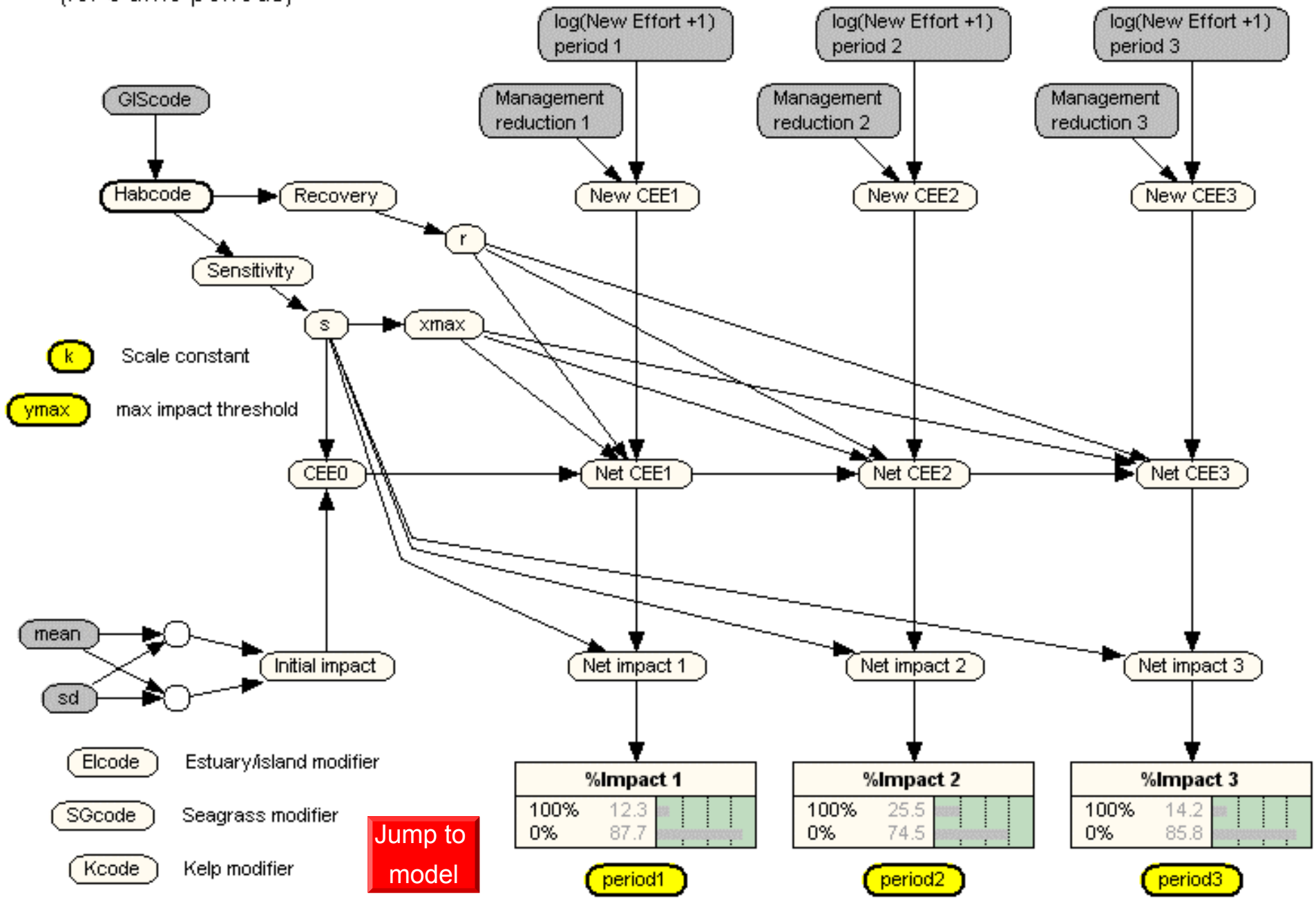
Effects of Data on Model Specification

Sensitivity and Recovery:

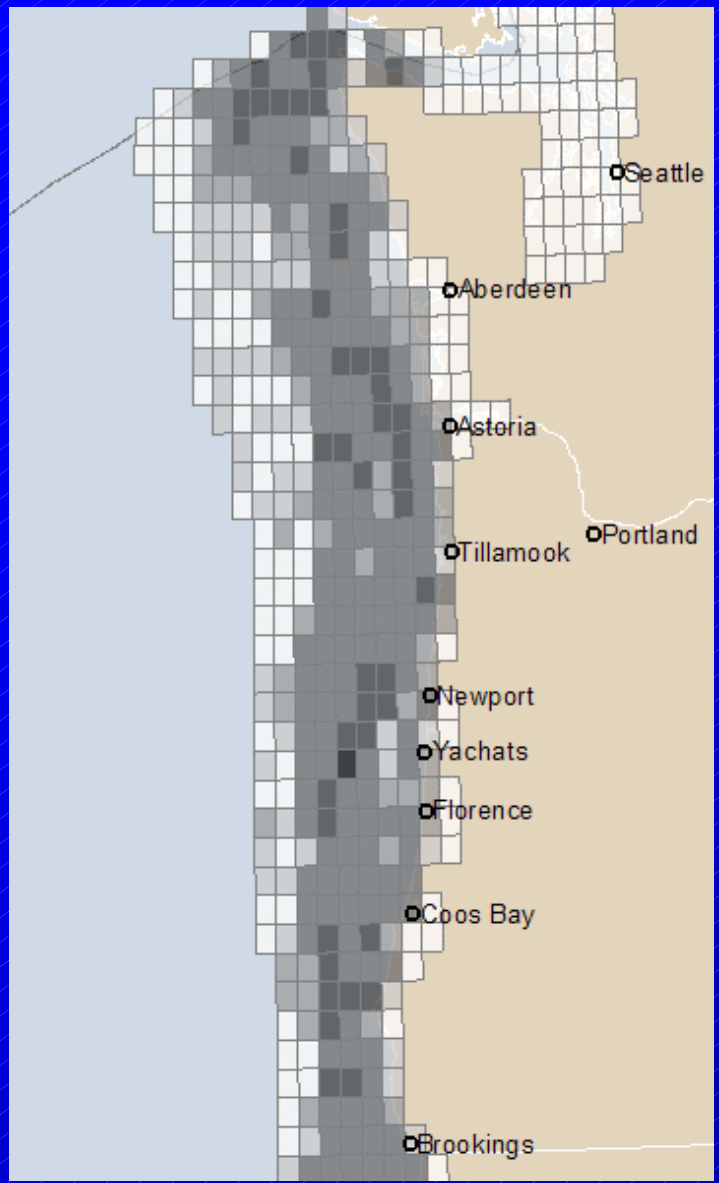
- The sensitivity index is a **relative measure**.
- There is no quantitative link between the sensitivity measure and habitat function.
- Unanswered questions remain: e.g. Is it possible for some fraction of a habitat area to be impacted and to remain in an impacted state without significantly affecting the utility of the whole area as habitat for managed species?
- Recovery index suffers from the limited capability of experiments to measure and detect change

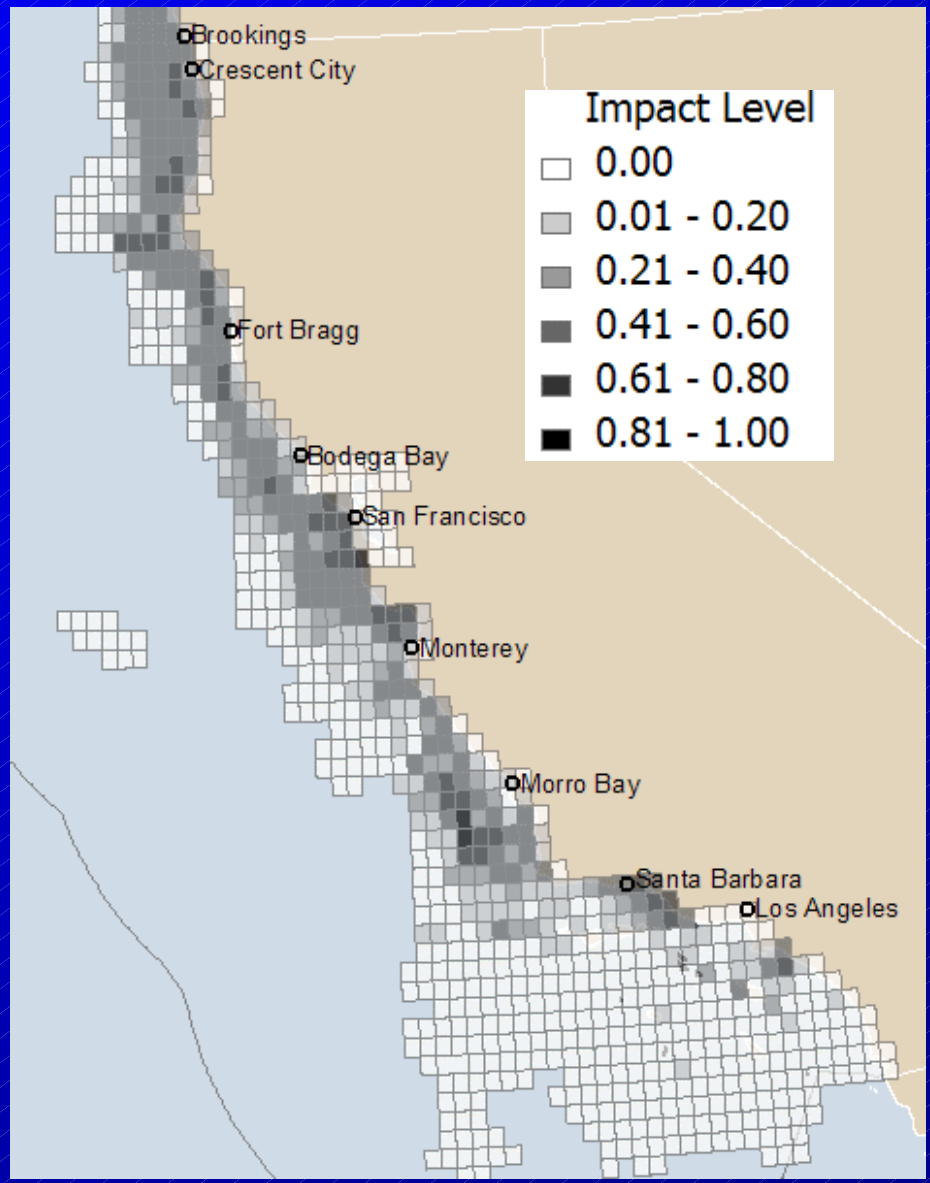
TRAWL IMPACTS MODEL

(for 3 time periods)



Trawl Impacts Model Output: 2002

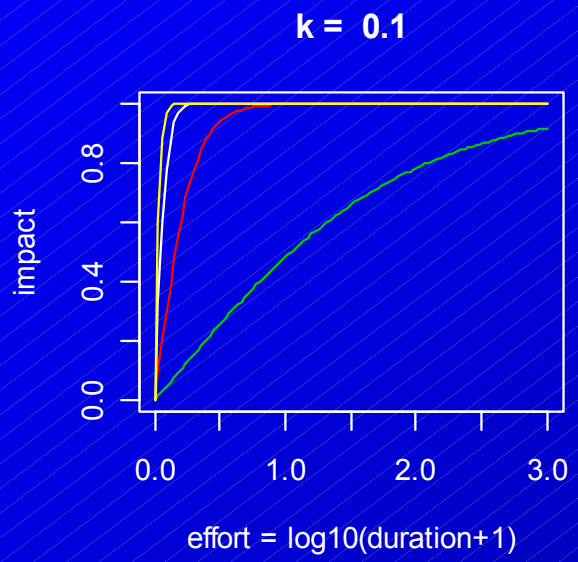


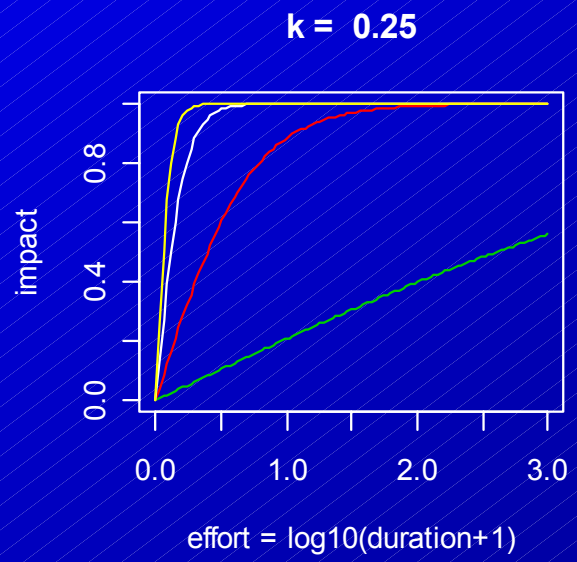


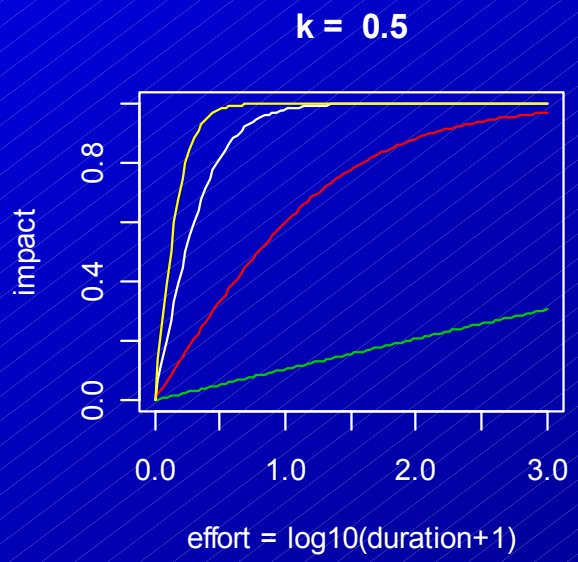
Tuning the Impacts Model

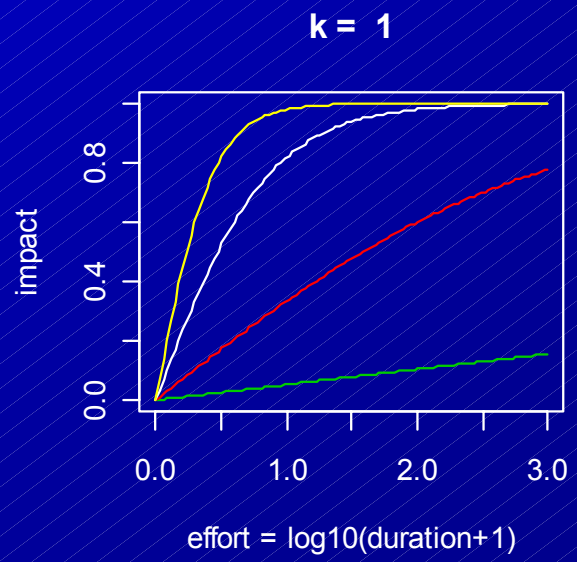
Choice of k depends on range of total duration (i.e. effort), and hence on period;

For a yearly interval, k in the range 0.1 to 1.5 seems OK.

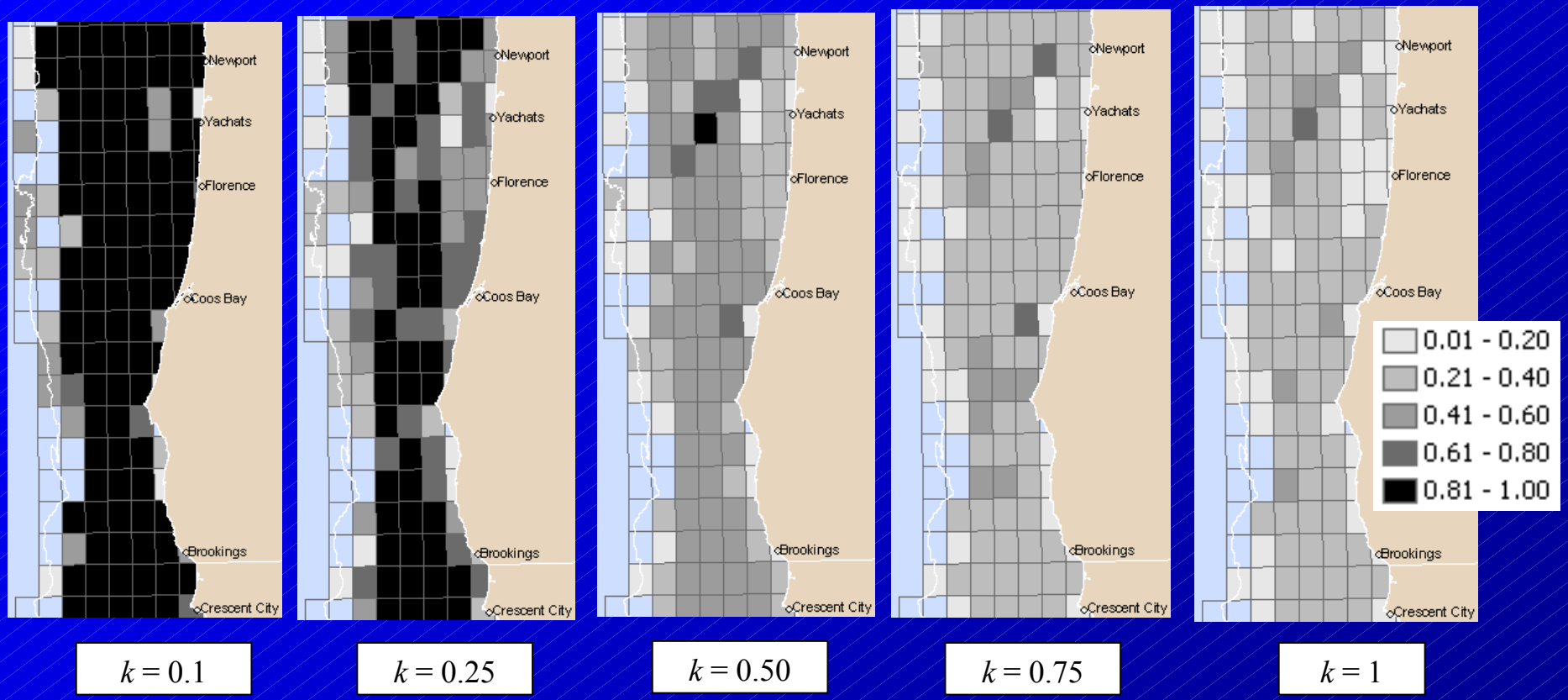








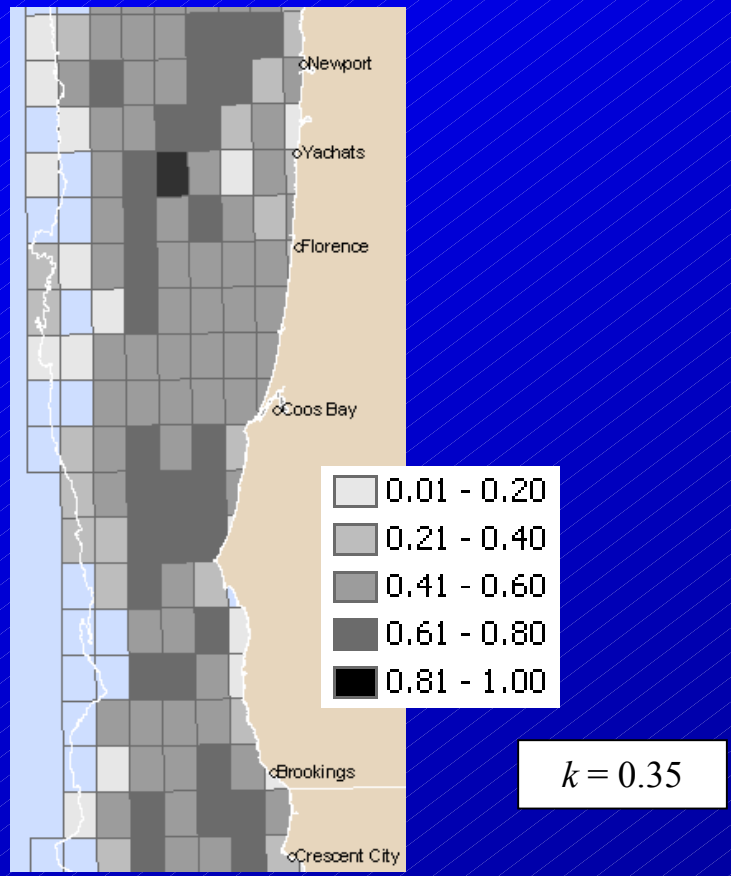
Tuning the Impacts Model



$k = 0.1$ $k = 0.25$ $k = 0.50$ $k = 0.75$ $k = 1$

Example maps depicting net cumulative impact from bottom trawls for various levels of the tuning constant k

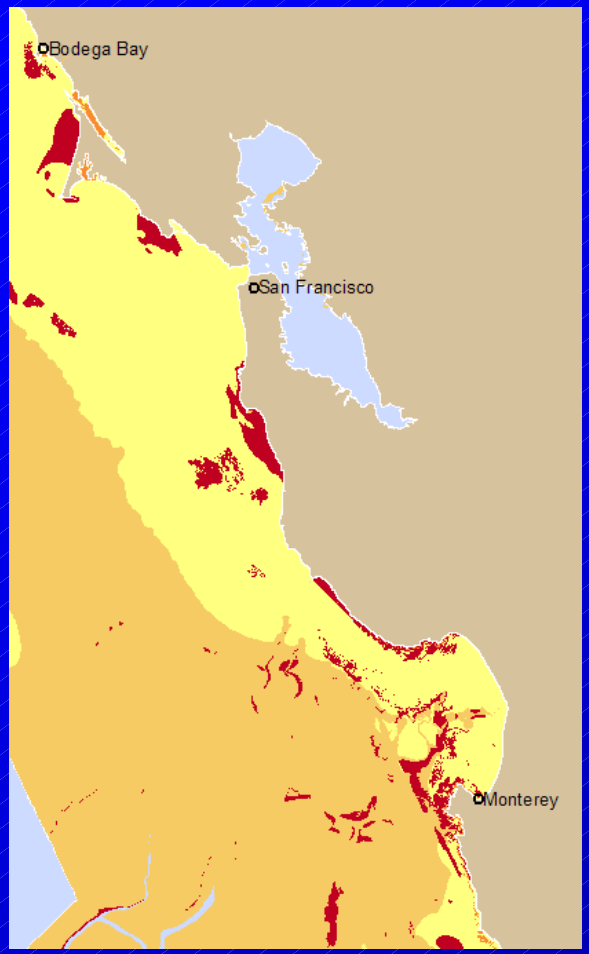
Tuning the Impacts Model



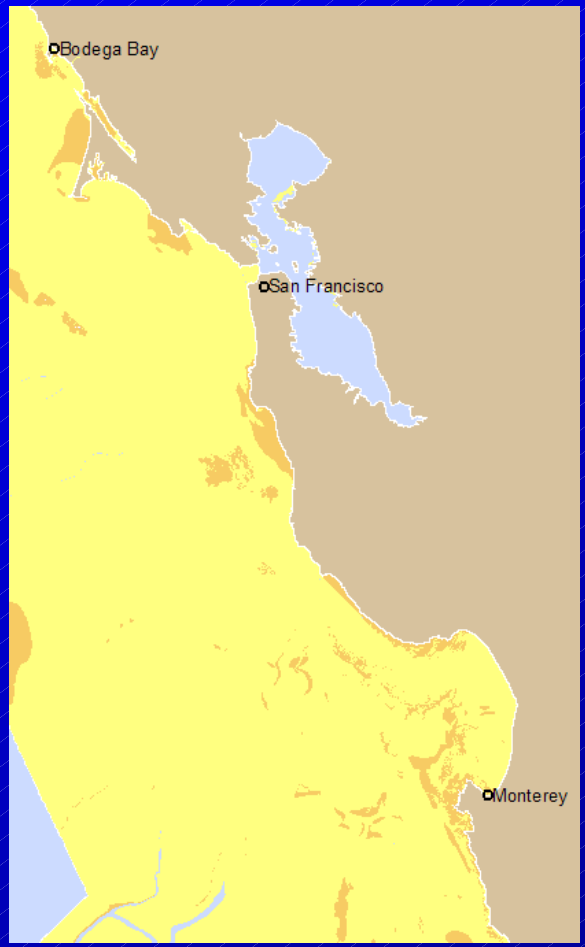
Return

Mean Habitat Sensitivity by Gear Type

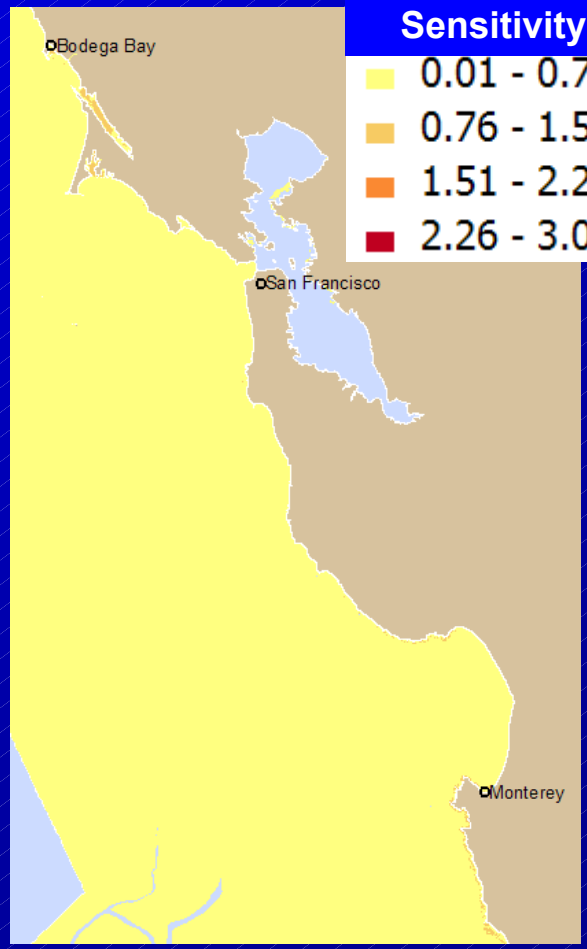
Bottom Trawl



Net

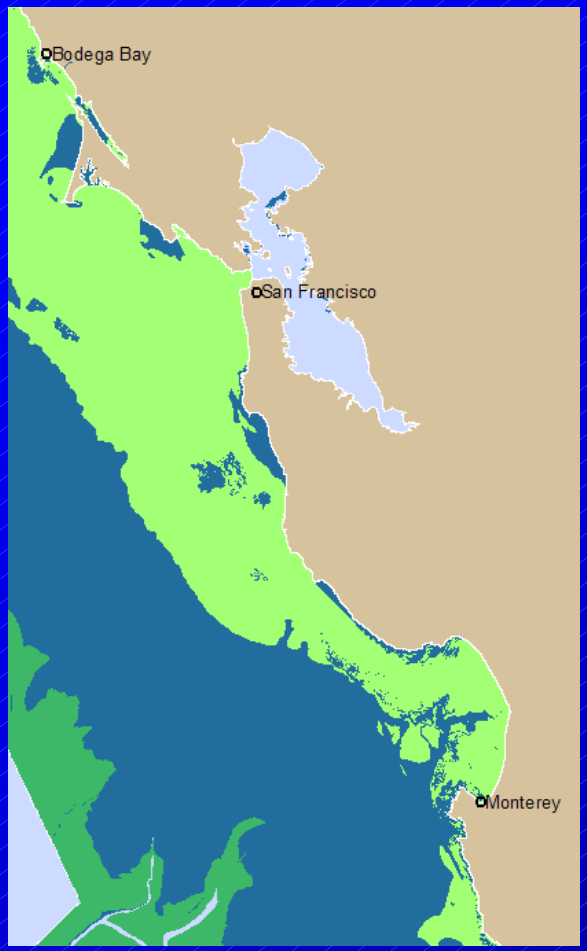


Pot/Trap and Hook & Line

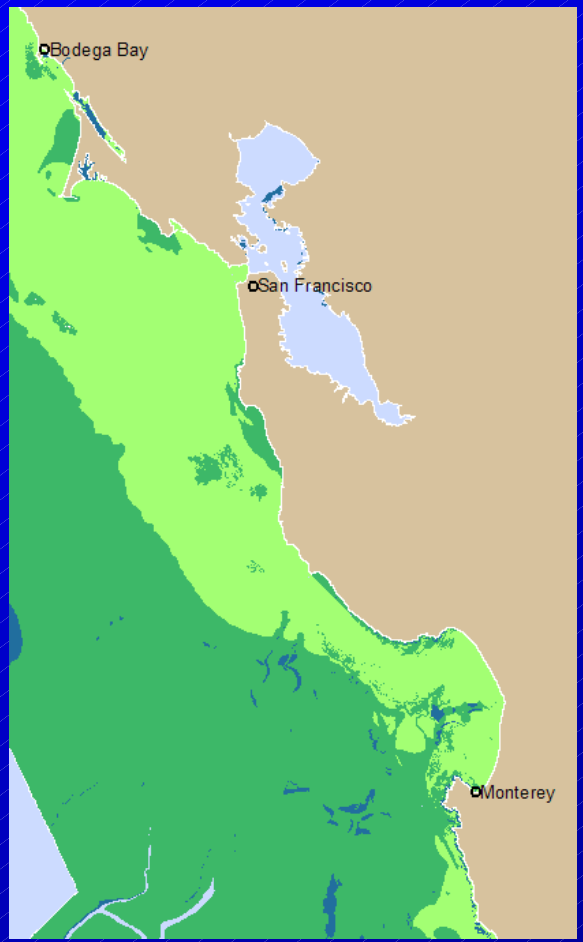


Mean Habitat Recovery by Gear Type

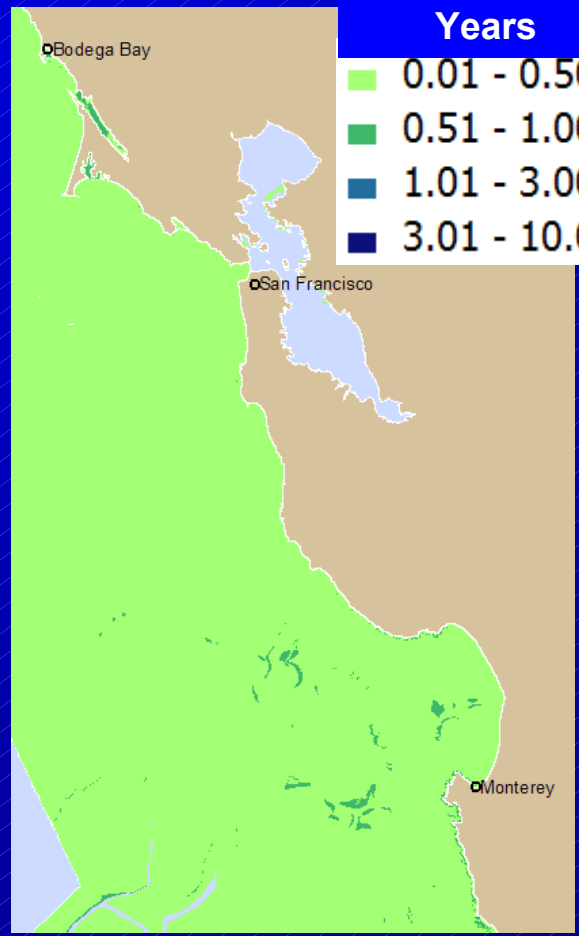
Bottom Trawl



Net



Pot/Trap and Hook & Line



Return

EFH GIS: Data Sources

Active Tectonics and Seafloor Mapping Lab, College of Oceanic and Atmospheric Sciences

Center for Habitat Studies at Moss Landing Marine Laboratories

NOAA, National Marine Fisheries Service, Alaska Fisheries Science Center, RACE Division

Washington Department of Fish and Wildlife

California Department of Fish and Game

Oregon Department of Fish and Wildlife

United States Fish and Wildlife Service

Morro Bay National Estuary Program

Merkel and Associates

NOAA, National Marine Fisheries Service, Restoration Center, Santa Rosa, California

NOAA, National Marine Fisheries Service, Northwest Fisheries Science Center

NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center

NOAA, National Marine Fisheries Service, Southwest Region

Wetlands Support

Point No Point Treaty Council

U.S. Navy SWDIV Naval Facilities Engineer Command

Port of San Diego

KTU+A

San Diego Association of Governments (SANDAG)

California Coastal Conservancy

NOAA, National Ocean Service, Office of Response and Restoration

Ecotrust

Oregon Department of Land Conservation and Development

South Slough National Estuarine Research Reserve

Earth Design Consultants

Tillamook County, Oregon

King County, Washington

Battelle Marine Sciences Lab

Washington Department of Natural Resources

Puget Sound Action Team

Output From the Comprehensive Risk Assessment

Maps Included with the Preliminary Groundfish EFH EIS

This is the end of the presentation …

Click here to view the maps on the Pacific Fishery Management Council website

The End

The End